Technical Memorandum 7-87

LIVE FIRE AND SIMULATOR MARKSMANSHIP PERFORMANCE WITH THE M16A1 RIFLE STUDY I: A VALIDATION OF THE ARTIFICIAL INTELLIGENCE DIRECT FIRE WEAPONS RESEARCH TEST BED

VOLUME II: APPENDIXES

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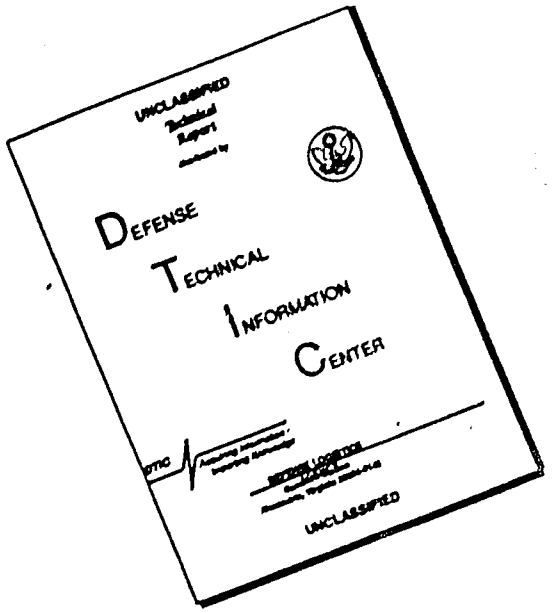

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The Project Manager for Training Devices (PM TRADE) together with the U.S. Army Human Engineering Laboratory (USAHEL) and Naval Training Systems Center (NTSC) are developing the Artificial Intelligence Direct Fire Weapons Research Test Bed (TB) to examine the use of expert systems to fill roles now performed by human instructors and to acquire the simulation data needed for designing future training systems for direct fire weapons.

This report describes two experiments that show the TB is a valid research tool for determining training system requirements for future direct fire weapon systems. These experiments were conducted to determine if the TB would predict real-world performance. If so, it would be a valid research tool. The experiments showed that the TB simulation predicted and could support the training of live fire rifle performance.

The first experiment involved 29 infantrymen who completed three marksmanship tasks on the TB and live fire ranges. They zeroed their rifles; slow fired 10 rounds at a stationary, distinct target; and fired at E-type silhouette targets in a day defense type scenario in which targets varied in range (60 to 300 meters), speed (0 to 12 feet per second), and exposure time (3.25 to 7.25 seconds). The results indicated that TB and field performance did not differ statistically for the rounds to zero, the standard deviation of aiming accuracy for slow fire, and proportion of targets hit for the day defense scenario.

In the second experiment nine male rifle-naive college students were taught M16A1 marksmanship skills using the TB rifle simulation. These students performed in the field as well as Army trained infantrymen on the zeroing, slow fire, and defense scenario tasks.

Detailed analyses showed that the TB exhibited all of the fundamental functional relationships characteristic of man/rifle performance normally obtained in the field. These were a decline in hit probability (overall and first round) as a function of target range, exposure time, and speed.

Finally, dependent measures based on rate of firing performance differed between the TB and the field. These results indicated the need to improve the fidelity with which recoil impulse was simulated.

Because the TB and field performance were similar and did not differ statistically on the primary dependent measures for the fundamental marksmanship tasks, the conclusion was reached that the TB is a valid research tool to determine the training system requirements for future direct fire weapons systems.

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APPENDIX A

DESCRIPTION OF STATIC AND MOVING TARGETS

DESCRIPTION OF STATIC AND MOVING TARGETS

STATIC TARGETS

TARGET	TARGET SPEED (FPS)	TARGET RANGE (M)	TARGET EXPOSURE TIME (SEC)	TARGET POSITION
1	0	60	3	L
2	0	60	3	C
3	0	60	3	R
4	0	60	5	L
5	0	60	5	C
6	0	60	5	R
7	0	60	7	L
8	0	60	7	C
9	0	60	7	R
10	0	120	3	L
11	0	120	3	C
12	0	120	3	R
13	0	120	5	L
14	0	120	5	C
15	0	120	5	R
16	0	120	7	L
17	0	120	7	C
18	0	120	7	R
19	0	180	3	L
20	0	180	3	C
21	0	180	3	R
22	0	180	5	L
23	0	180	5	C
24	0	180	5	R
25	0	180	7	L
26	0	180	7	C
27	0	180	7	R
28	0	250	3	L
29	0	250	3	C
30	0	250	3	R
31	0	250	5	L
32	0	250	5	C
33	0	250	5	R
34	0	250	7	L
35	0	250	7	C
36	0	250	7	R
37	0	300	3	L
38	0	300	3	C
39	0	300	3	R
40	0	300	5	L
41	0	300	5	C
42	0	300	5	R
43	0	300	7	L
44	0	300	7	C
45	0	300	7	R

MOVING TARGETS

TARGET	TARGET SPEED (FPS)	TARGET RANGE (M)	TARGET EXPOSURE TIME (SEC)	TARGET POSITION
1	6	60	3	L
2	6	60	3	R
3	6	60	5	L
4	6	60	5	R
5	6	120	3	L
6	6	120	3	R
7	6	120	5	L
8	6	120	5	R
9	6	180	3	L
10	6	180	3	R
11	6	180	5	L
12	6	180	5	R
13	12	60	3	L
14	12	60	3	R
15	12	60	5	L
16	12	60	5	R
17	12	120	3	L
18	12	120	3	R
19	12	120	5	L
20	12	120	5	R
21	12	180	3	L
22	12	180	3	R
23	12	180	5	L
24	12	180	5	R

APPENDIX B

SCENARIO RANDOM SEQUENCES

RANDOM SEQUENCE ASSIGNMENTS: PARAMETRIC EXPERIMENT

GROUP	SCENARIO	SUBJECT														
TEST BED:																
ALPHA	I	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	II	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
BRAVO	I	1	2	3	4	5	6	7	8	9	10	11	12	13	14	--
	II	16	17	18	19	20	21	22	23	24	25	26	27	28	29	--
FIELD:																
ALPHA	I	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	II	4	5	6	4	5	6	4	5	6	4	5	6	4	5	6
BRAVO	I	1	2	3	1	2	3	1	2	3	1	2	3	1	2	-
	II	4	5	6	4	5	6	4	5	6	4	5	6	4	5	-

RANDOM SEQUENCE ASSIGNMENTS: TRAINING EXPERIMENT

GROUP	SCENARIO	SUBJECT								
		1	2	3	4	5	6	7	8	9
ROTC	I	1	2	2	3	1	2	1	3	3
	II	4	5	5	6	4	5	4	6	6

MASTER TABLE OF TARGETS

TARGET #	SPEED (FPS)	RANGE (M)	TIME (SEC)	POSITION
1	0	60	3	R
2	0	60	3	C
3	0	60	3	L
4	0	60	5	R
5	0	60	5	C
6	0	60	5	L
7	0	60	7	L
8	0	60	7	R
9	0	60	7	C
10	6	60	3	R
11	6	60	3	L
12	6	60	5	R
13	6	60	5	L
14	12	60	3	R
15	12	60	3	L
16	12	60	5	R
17	12	60	5	L
18	0	120	3	R
19	0	120	3	C
20	0	120	3	L
21	0	120	5	R
22	0	120	5	C
23	0	120	5	L
24	0	120	7	L
25	0	120	7	R
26	0	120	7	C
27	6	120	3	R
28	6	120	3	L
29	6	120	5	R
30	6	120	5	L
31	12	120	3	R
32	12	120	3	L
33	12	120	5	R
34	12	120	5	L
35	0	180	3	R
36	0	180	3	C
37	0	180	3	L
38	0	180	5	R
39	0	180	5	C
40	0	180	5	L
41	0	180	7	L
42	0	180	7	R
43	0	180	7	C

MASTER TABLE OF TARGETS

TARGET #	SPEED (FPS)	RANGE (M)	TIME (SEC)	POSITION
44	6	180	3	R
45	6	180	3	L
46	6	180	5	R
47	6	180	5	L
48	12	180	3	R
49	12	180	3	L
50	12	180	5	R
51	12	180	5	L
52	0	250	3	R
53	0	250	3	C
54	0	250	3	L
55	0	250	5	R
56	0	250	5	C
57	0	250	5	L
58	0	250	7	L
59	0	250	7	R
60	0	250	7	C
61	0	300	3	R
62	0	300	3	C
63	0	300	3	L
64	0	300	5	R
65	0	300	5	C
66	0	300	5	L
67	0	300	7	L
68	0	300	7	R
69	0	300	7	C

TARGET #	SPEED (FPS)	RANGE (M)	TIME (SEC)	POSITION
1	0	60	3	R
2	0	60	3	C
3	0	60	3	L
4	0	60	5	R
5	0	60	5	C
6	0	60	5	L
7	0	60	7	L
8	0	60	7	R
9	0	60	7	C
10	6	60	3	R
11	6	60	3	L
12	6	60	5	R
13	6	60	5	L
14	12	60	3	R
15	12	60	3	L
16	12	60	5	R
17	12	60	5	L
18	0	120	3	R
19	0	120	3	C
20	0	120	3	L
21	0	120	5	R
22	0	120	5	C
23	0	120	5	L
24	0	120	7	L
25	0	120	7	R
26	0	120	7	C
27	6	120	3	R
28	6	120	3	L
29	6	120	5	R
30	6	120	5	L
31	12	120	3	R
32	12	120	3	L
33	12	120	5	R
34	12	120	5	L
35	0	180	3	R
36	0	180	3	C
37	0	180	3	L
38	0	180	5	R
39	0	180	5	C
40	0	180	5	L
41	0	180	7	L
42	0	180	7	R
43	0	180	7	C
44	6	180	3	R
45	6	180	3	L
46	6	180	5	R
47	6	180	5	L
48	12	180	3	R
49	12	180	3	L
50	12	180	5	R
51	12	180	5	L
52	0	250	3	R
53	0	250	3	C
54	0	250	3	L
55	0	250	5	R
56	0	250	5	C
57	0	250	5	L
58	0	250	7	L
59	0	250	7	R
60	0	250	7	C
61	0	300	3	R
62	0	300	3	C
63	0	300	3	L
64	0	300	5	R
65	0	300	5	C
66	0	300	5	L
67	0	300	7	L
68	0	300	7	R
69	0	300	7	C

TRIAL	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S12	S13	S14	S1
1.	25	69	25	29	69	57	39	45	9	25	69	64	24	53	9
2.	5	48	67	18	52	55	9	46	39	67	45	17	58	25	8
3.	17	18	32	57	33	31	51	6	11	30	5	15	60	18	1
4.	51	22	7	37	13	37	14	42	62	69	40	10	49	20	9
5.	15	36	62	58	56	7	42	58	63	3	50	63	31	29	4
6.	48	21	44	15	6	59	52	40	31	46	12	4	27	59	6
7.	6	3	58	53	20	69	4	67	35	52	36	11	15	24	1
8.	24	40	18	40	66	67	45	50	69	39	35	31	9	28	6
9.	18	5	1	42	1	64	21	13	22	43	28	29	5	19	2
10.	29	13	55	32	41	3	18	43	7	42	57	23	12	4	3
11.	3	31	40	28	27	33	37	69	56	9	21	12	25	60	1
12.	37	2	29	13	3	25	60	25	60	20	25	69	42	39	4
13.	58	9	27	34	57	63	23	15	3	37	34	30	56	45	2
14.	11	35	52	17	31	12	17	8	37	40	43	42	3	51	6
15.	30	55	5	5	19	34	34	49	47	44	26	52	53	44	4
16.	14	16	19	16	47	51	53	10	15	48	41	5	7	11	6
17.	22	38	9	48	40	8	6	2	17	11	14	49	50	17	1
18.	10	59	57	69	24	19	50	66	65	16	65	32	26	68	2
19.	59	10	4	49	63	36	35	24	49	47	47	40	57	65	5
20.	53	20	54	22	18	48	38	39	33	28	44	20	35	64	3
21.	65	27	23	5	34	30	57	18	55	26	55	37	41	7	2
22.	52	45	21	11	39	27	65	30	13	10	59	36	69	26	4
23.	4	42	26	41	11	35	16	19	6	36	4	22	44	58	6
24.	43	60	43	36	32	22	63	54	53	50	10	16	22	32	6
25.	44	49	6	59	22	44	24	7	10	33	67	39	29	33	5
26.	62	30	69	23	51	58	69	20	36	59	23	14	46	49	1
27.	46	58	12	7	35	20	54	21	58	61	9	9	4	63	6
28.	68	26	8	46	2	23	49	36	24	38	33	55	55	2	
29.	60	46	36	39	65	60	20	14	38	32	52	54	10	50	2
30.	29	41	59	2	21	42	27	17	48	56	17	43	37	30	3

TRIAL	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S12	S13	S14	S1
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32.	50	67	45	12	43	18	41	55	59	27	27	25	67	62	1
33.	40	11	49	55	15	38	58	4	46	19	20	28	2	34	
34.	8	7	66	27	48	62	30	1	66	45	16	13	11	38	1
35.	63	17	14	1	12	41	3	5	69	24	56	62	36	61	3
36.	23	37	48	8	62	24	31	35	52	17	53	68	18	27	3
37.	61	65	15	64	61	1	68	26	2	21	32	61	30	35	5
38.	38	66	68	31	29	61	7	37	44	7	29	51	43	12	1
39.	2	6	20	52	36	15	25	22	57	53	62	18	13	47	3
40.	64	52	2	14	17	2	19	47	18	2	2	57	63	8	6
41.	47	64	34	6	25	14	11	9	64	22	49	41	65	67	4
42.	55	55	46	10	55	53	26	48	27	58	69	56	6	15	5
43.	32	25	42	4	3	68	55	62	26	31	7	27	23	36	1
44.	1	61	33	56	28	10	13	60	67	14	38	49	33	55	2
45.	19	14	61	66	16	5	47	29	21	4	39	8	59	3	2
46.	45	12	60	3	10	13	15	31	8	1	63	44	47	23	4
47.	56	28	3	47	53	56	12	59	19	12	31	26	66	42	3
48.	20	62	39	44	67	45	8	51	45	60	1	67	14	69	4
49.	9	4	51	25	64	21	5	27	32	23	9	60	21	31	5
50.	49	43	35	61	58	29	28	16	23	64	6	34	28	6	1
51.	12	29	41	21	46	52	62	63	40	65	15	2	52	10	
52.	31	19	11	20	30	40	46	34	14	62	48	3	61	48	
53.	35	50	17	60	44	50	61	12	41	8	61	50	43	46	3
54.	7	54	38	38	42	9	64	11	12	66	64	58	51	1	
55.	36	39	13	43	68	46	43	44	42	55	42	21	38	54	4
56.	34	32	31	63	54	47	10	3	61	13	19	19	32	43	3
57.	26	47	16	51	60	43	40	52	20	57	13	45	9	5	2
58.	21	51	50	19	7	11	29	56	28	15	58	35	64	9	5
59.	57	33	65	26	14	65	33	38	29	49	24	65	39	2	5
60.	33	63	22	65	37	66	56	57	51	63	56	66	20	13	

TRIAL	S01	S02	S03	S04	S05	S06	S07	S08	SC9	S10	S11	S12	S13	S14	S1
61.	27	24	47	67	26	32	32	41	5	68	3	59	16	41	3
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63.	16	23	64	68	4	17	36	23	50	34	22	53	54	16	2
64.	39	68	28	24	23	39	59	61	25	54	18	24	17	66	2
65.	42	15	53	33	50	26	67	53	1	35	60	7	40	52	5
66.	13	8	10	9	9	28	1	32	4	51	30	6	1	57	
67.	66	57	56	30	45	49	66	64	34	5	11	38	45	40	4
68.	41	53	63	45	5	4	2	33	30	29	51	1	34	37	
69.	69	1	37	35	38	16	48	68	43	18	46	33	62	14	

TRIAL	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S
1.	15	33	65	20	11	13	3	36	9	59	50	38	44	52	
2.	7	43	27	37	53	61	2	58	38	60	2	4	41	19	
3.	42	30	63	36	5	40	53	26	8	33	56	27	56	58	
4.	46	5	59	23	40	39	19	52	50	11	31	58	32	40	
5.	39	28	68	64	51	12	58	6	17	44	34	29	37	65	
6.	24	52	15	35	9	65	35	11	68	25	60	68	1	29	
7.	5	57	38	>4	18	3	38	33	47	35	51	10	19	13	
8.	16	13	26	8	24	57	49	28	14	53	43	6	21	19	
9.	53	54	18	48	43	68	17	12	13	67	10	9	48	32	
10.	32	62	16	6	68	35	8	27	21	64	19	55	25	54	
11.	61	26	69	25	21	15	34	66	5	61	18	48	2	30	
12.	10	10	60	62	42	51	62	68	31	66	6	2	63	48	
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27.	22	56	49	2	7	66	60	20	41	54	15	43	35	35	
28.	20	45	56	68	49	21	43	18	40	45	63	44	43	63	
29.	41	32	37	63	31	18	66	61	28	23	35	12	33	15	
30.	14	8	33	45	39	55	11	67	36	13	57	41	17	24	

TRIAL	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S3
31.	9	48	20	52	36	25	27	29	61	15	26	14	6	66	3
32.	12	23	34	32	64	50	30	4	67	42	46	57	39	50	4
33.	25	55	19	55	60	8	5	7	64	48	24	8	42	5	5
34.	8	27	64	43	33	26	45	22	4	69	8	50	27	1	2
35.	58	38	2	38	2	24	36	35	18	20	47	40	47	28	6
36.	33	51	55	34	63	2	29	9	49	38	62	3	23	69	1
37.	17	31	11	17	56	1	18	21	2	68	21	49	64	61	4
38.	67	25	43	1	62	27	33	38	30	1	3	20	38	17	
39.	44	12	17	19	55	14	56	62	42	12	65	28	69	56	4
40.	60	67	62	30	30	49	59	2	26	63	33	23	3	23	2
41.	23	65	8	42	35	62	15	42	56	5	64	33	20	51	6
42.	27	49	53	59	4	64	63	40	58	40	9	56	26	25	1
43.	1	14	32	7	25	36	28	31	19	34	53	60	67	12	6
44.	6	18	22	40	44	52	69	5	12	56	28	18	62	33	4
45.	47	6	42	12	34	19	39	10	59	27	13	59	49	10	5
46.	19	24	52	33	17	31	22	25	54	8	25	65	54	16	1
47.	38	66	48	69	6	7	68	30	16	57	55	22	40	38	3
48.	68	29	30	3	3	38	21	41	32	19	44	61	18	14	6
49.	35	58	45	57	45	43	47	49	45	46	39	34	60	2	6
50.	48	3	54	56	43	44	31	63	25	31	23	35	29	31	1
51.	49	15	50	31	54	22	41	19	57	17	22	64	30	37	2
52.	69	16	21	21	29	63	16	46	24	43	27	45	58	41	1
53.	43	20	51	10	1	28	40	37	33	30	61	46	46	26	1
54.	57	44	47	4	14	9	10	65	43	2	52	15	53	2	4
55.	26	39	1	14	37	30	14	69	10	39	4	1	12	57	
56.	3	69	35	26	15	48	48	3	55	32	7	32	13	60	1
57.	31	69	41	66	57	4	9	54	53	22	1	19	5	46	2
58.	21	11	23	41	10	46	32	1	22	41	42	62	24	68	5
59.	4	19	57	27	65	29	12	59	27	16	49	69	59	36	
60.	65	47	13	50	22	53	67	51	44	4	16	52	16	44	1

TRIAL	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S3
61.	51	4	9	60	52	59	20	16	3	50	11	36	11	21	4
62.	62	35	39	18	23	33	50	64	11	7	20	31	51	8	5
63.	13	9	24	58	16	10	52	13	63	47	68	54	9	7	3
64.	34	46	46	61	13	37	23	43	66	9	69	25	50	9	3
65.	28	50	25	53	69	47	37	24	46	51	32	16	52	22	2
66.	36	34	12	13	19	60	6	55	29	58	37	37	31	59	5
67.	13	64	5	51	47	45	1	57	35	29	48	63	65	39	1
68.	30	60	61	39	28	54	46	15	69	21	29	47	55	49	3
69.	37	1	28	9	50	20	44	34	23	24	58	5	66	53	2

APPENDIX C

SCENARIO RANDOM TIME DELAYS

	SEQUENCE														
TRIAL INTERVAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0-1	10	8	10	7	7	7	9	9	8	8	8	10	10	10	7
1-2	8	7	8	9	7	7	9	10	9	7	9	9	9	9	9
2-3	10	9	10	10	10	9	7	9	7	8	8	8	9	8	9
3-4	10	8	7	9	9	10	9	9	9	7	9	10	9	7	7
4-5	10	9	9	10	9	9	10	7	10	9	7	7	9	9	7
5-6	10	10	7	8	7	10	10	7	8	8	8	9	9	8	8
6-7	8	9	7	10	8	7	9	10	7	8	8	9	9	8	8
7-8	7	9	9	10	8	10	9	10	8	10	8	8	7	9	7
8-9	9	8	8	7	7	10	9	7	10	10	7	7	7	8	8
9-10	9	9	10	8	10	8	9	9	7	9	7	9	8	7	7
10-11	7	9	9	7	9	7	8	7	7	8	10	8	8	7	7
11-12	9	8	7	9	7	7	8	8	10	8	9	10	9	7	9
13-14	9	9	8	7	10	9	10	7	7	10	7	8	8	9	8
14-15	10	8	10	7	8	8	7	10	8	10	7	7	8	9	10
15-16	10	10	9	7	8	8	9	9	8	10	9	9	10	9	9
16-17	7	9	10	10	10	10	8	9	7	8	9	10	7	10	7
17-18	10	9	10	10	9	7	7	9	8	8	8	7	7	8	7
18-19	9	10	8	10	8	10	8	8	9	7	10	10	10	8	8
19-20	9	9	10	10	10	9	10	9	7	9	8	9	10	10	9
20-21	9	9	8	8	7	9	8	9	10	8	9	10	10	10	7
21-22	9	7	10	9	10	10	8	10	8	9	9	9	8	8	7
22-23	7	9	9	7	10	10	10	7	9	8	10	9	7	9	9
23-24	10	9	8	9	9	9	10	10	9	8	10	7	8	9	7
24-25	9	9	8	7	7	8	9	10	7	9	9	8	7	7	7
25-26	9	10	9	9	10	8	10	8	8	9	10	8	10	8	8
26-27	9	10	9	7	10	9	9	8	9	7	7	7	7	9	9
27-28	10	10	10	7	9	8	7	9	9	7	8	8	9	8	10
28-29	7	7	7	8	7	8	9	10	8	7	9	7	7	8	7
29-30	10	9	9	7	8	9	9	10	7	10	10	7	10	9	10
30-31	10	8	9	9	7	7	9	8	8	8	9	7	10	7	7
31-32	10	8	8	9	7	9	10	10	7	9	10	10	8	9	7
32-33	10	7	7	7	7	7	9	7	8	7	7	8	7	10	10
33-34	8	9	9	7	7	9	9	10	10	7	8	7	7	9	7
34-35	10	7	8	9	9	8	9	8	8	8	8	8	9	9	9

SEQUENCE

TRIAL INTERVAL	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0-1	10	10	10	9	10	8	8	9	9	10	8	9	10	10	9
1-2	8	8	10	9	7	9	9	10	7	8	7	7	10	10	9
2-3	7	8	10	8	10	8	7	9	10	8	9	10	7	9	8
3-4	8	10	9	8	9	8	10	7	10	10	10	9	7	10	7
4-5	9	10	9	8	7	8	7	10	8	8	8	8	9	7	9
5-6	7	8	9	9	8	10	10	10	7	8	9	10	9	10	10
6-7	7	8	10	9	7	9	7	8	7	10	9	8	10	8	7
7-8	10	9	7	8	8	7	10	10	8	7	8	9	8	7	9
8-9	8	8	10	7	7	10	10	10	7	9	7	10	7	9	10
9-10	10	9	8	9	10	8	7	9	8	7	8	10	10	7	9
10-11	7	8	9	10	9	9	8	8	8	9	8	8	10	9	9
11-12	9	8	9	9	9	10	8	7	7	10	7	9	7	10	7
13-14	9	9	7	8	8	10	10	8	10	9	8	9	9	7	9
14-15	10	10	8	7	9	7	7	10	8	8	7	7	8	7	7
15-16	10	8	8	7	8	9	9	10	9	10	7	8	9	10	10
16-17	7	8	10	7	10	9	10	9	8	10	9	8	7	10	10
17-18	10	8	10	9	9	7	9	7	7	10	7	8	9	9	8
18-19	9	9	10	9	7	8	10	10	10	10	7	9	10	9	9
19-20	10	9	9	10	9	10	9	8	7	7	8	9	7	10	10
20-21	9	10	9	8	8	9	9	9	10	8	10	9	7	9	10
21-22	9	9	7	7	8	9	8	8	7	8	10	7	10	7	7
22-23	10	7	7	9	10	9	9	7	8	8	10	10	8	8	8
23-24	7	7	9	9	8	10	8	10	8	7	8	8	9	7	9
24-25	10	9	10	7	10	8	9	7	8	9	7	10	10	10	8
25-26	10	9	8	10	8	10	10	9	8	10	10	8	9	7	7
26-27	7	8	9	7	8	8	10	8	10	7	7	8	9	8	8
27-28	9	8	10	10	9	8	9	8	7	9	7	10	8	7	9
28-29	9	9	10	9	9	8	9	7	9	9	9	9	8	8	9
29-30	10	7	8	10	10	9	10	7	7	10	9	7	9	7	9
30-31	7	9	8	7	9	9	7	9	10	10	7	7	10	7	7
31-32	10	9	8	8	8	10	9	9	7	8	10	10	9	10	7
32-33	8	7	10	10	10	8	10	10	9	9	10	10	8	10	7
33-34	9	7	7	9	10	7	9	7	10	7	8	9	7	7	8
34-35	7	8	8	7	9	9	9	10	10	9	9	7	10	10	8
35-36	9	9	9	7	10	10	7	10	8	10	10	8	10	9	9

APPENDIX D

TB HARDWARE AND SOFTWARE DESCRIPTION

The TB is a complex multiprocessor system. It consists of integrated software and hardware that perform the functions of rifle simulation, system monitoring, target motor control, target tracking, and target and performance feedback. System organization is shown in Figure 1D.

HARDWARE DESCRIPTION

The TB hardware is divided into three subsystems: the Shooter's Station, the Target Board, and the Experimenter's Station. These subsystems are housed in a single facility laid out according to Figure 2D. Hardware components are organized according to Figure 3D.

SHOOTER'S STATION

The Shooter's Station is divided into four components: rifle simulation, rifle sensing instrumentation, shooter feedback, and firing platform.

Rifle Simulation

This component consists of a demilitarized M16A1 rifle with its firing mechanism replaced by instrumentation designed to sense various rifle functions. All hardware needed to activate the rifle's functions has been retained.

A Charged Couple Device (CCD) camera is attached to the front end of the rifle barrel. It is boresighted to the rifle's front sight. This was accomplished by first approximately mechanically boresighting the camera and then by electronically positioning it precisely via the system computer.

During firing, the camera senses the point in space where first the rifle is aimed relative to target center of mass. It does this by first detecting the output of an Infrared Emitting Diode (IRED) fixed on the target and then determining the shooter's aiming error in azimuth and elevation. Next, the error data are combined with range data and gravity drop to determine the "bullet" strike point. The effects of round-to-round dispersion may be included in the determination of "bullet" strike.

If the target is moving, lead is incorporated in the "bullet" strike determination. Lead is a function of both target range and velocity. Target range is known to the system for each target. Target velocity is determined from the step count divided by the fundamental period of the system, i.e., 50 milliseconds.

"Bullet" strike as well as aiming point prior to and at the time of firing are displayed on an RGB graphics monitor located so that it may be viewed by the shooter if this is called for by an experiment or test.

To add realism, the muzzle climb associated with rifle recoil is simulated.

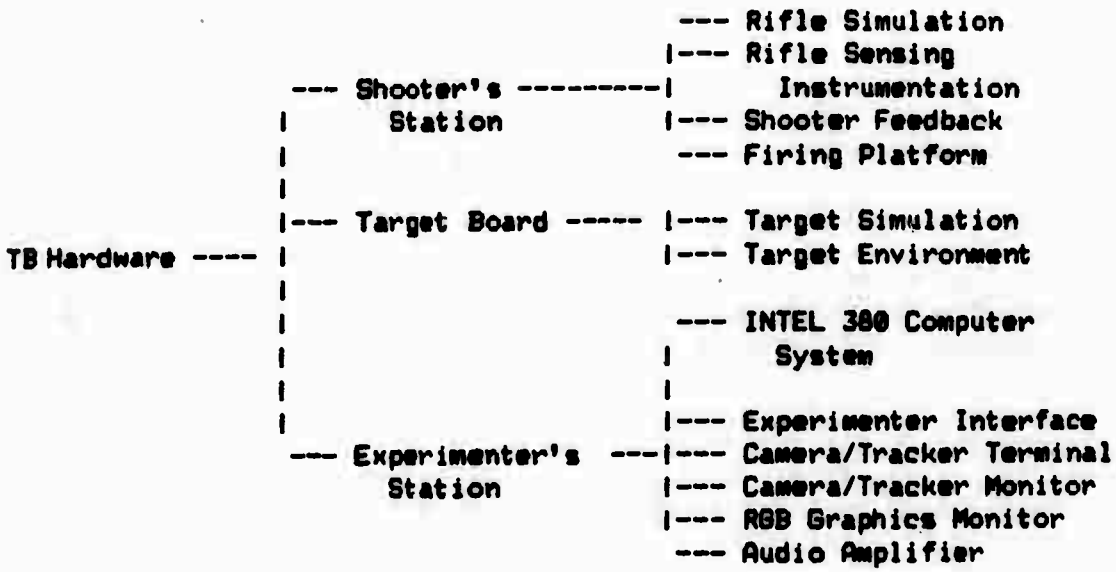

Figure 1D. Major components of the AI Test Bed at the time of the validation study.

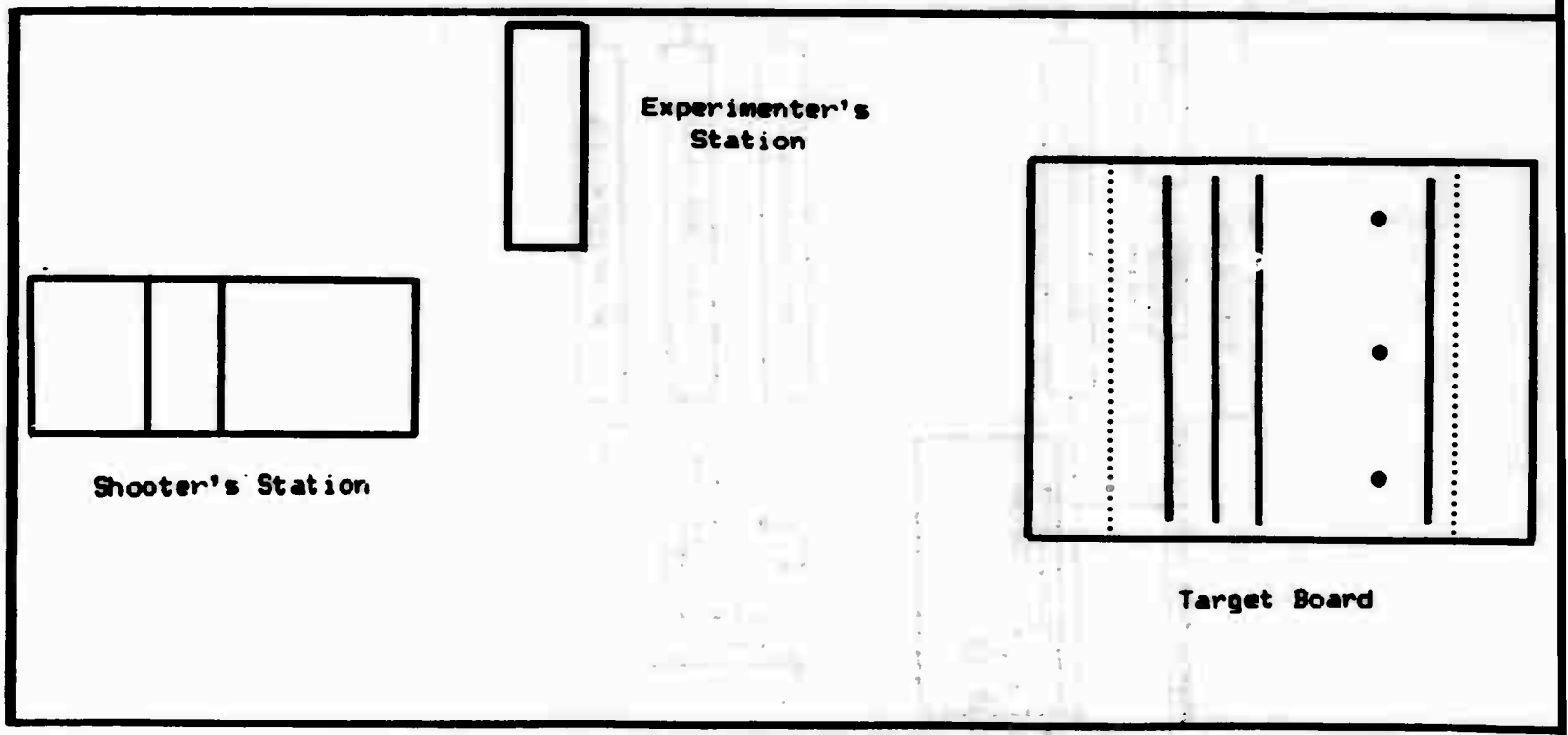

Figure 2D. Layout of Test Bed facility.

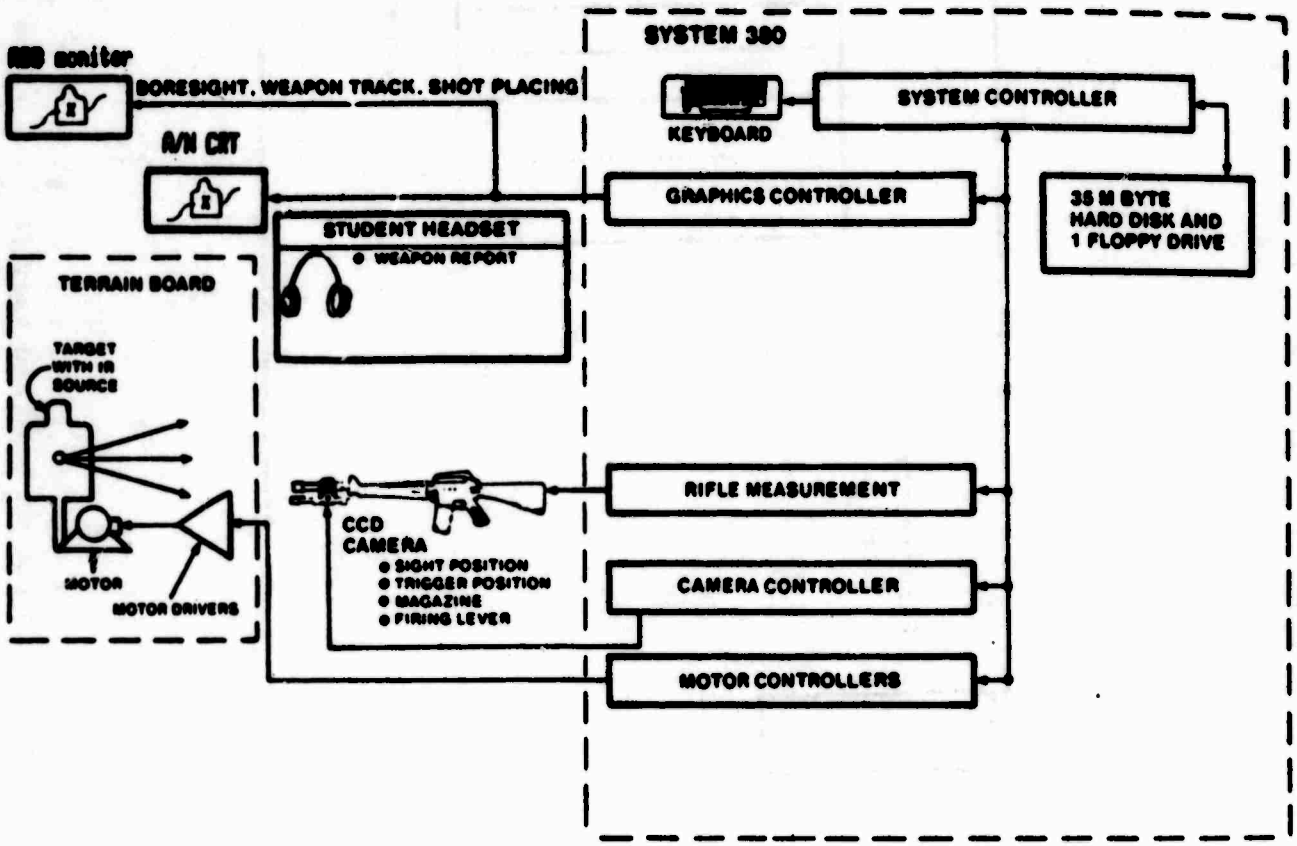

Figure 3D. Test Bed hardware organization.

Appearance, Weight, Balance, and Handling Characteristics. For the most part, the TB rifle's appearance is identical to that of the M16A rifle. Exceptions include the CCD camera, an umbilical cord containing wiring connecting the rifle to the computer system, and an air hose for the recoil simulation hardware.

Removal of the rifle firing mechanism and the addition of the CCD camera and instrumentation altered the rifle's weight and weight distribution. Care was taken, however, to rebalance the rifle after the alteration. People experienced in using an actual M16A1 rifle report no differences in the handling characteristics of the TB rifle compared to an actual M16A1.

Recoil Simulation. Recoil effects are simulated by a pneumatic impulse applied to the front end of the rifle barrel and normal to the direction of fire so that the barrel is displaced upwards and to the right. This displacement is approximately 22 milliradians. The direction of the pneumatic impulse is adjustable to provide up-and-to-the-right or up-and-to-the-left muzzle climb. The overall effect of the impulse is to disturb the shooter's aim point and force him to reaim between shots. The impulse is delivered via a blast of compressed air through a hose running into the TB rifle and out to its barrel. During the validation experiments air pressure was maintained at 168 to 170 psi to provide maximum muzzle climb.

Rifle Report. Rifle report is generated by a set of "bang boards" and amplified by an Altec Lansing Mixer/Preamp (Model 1692A) and an Altec Lansing Power Amp (Model 1269). The simulated report is then fed to a set of earphones worn by the shooter. The "bang boards" are activated by squeezing the rifle's trigger which is then sensed by the system software. Report level is adjustable by means of the Altec Lansing amplifiers and varies from 0 to 140 db. The "bang boards" are housed in an area behind the shooter's station.

Sight Selection and Adjustment. The actual rifle hardware has been retained to support this function.

Charging Action. The rifle's charging handle has been retained. The bolt in the upper receiver was removed. As such, there is no bolt action during simulated firing.

Reloading Action. The rifle hardware for this function has been retained.

Firing Mode Selection. The rifle hardware for this function has been retained.

Trigger Operation. The rifle trigger has been retained. A sensor to measure trigger displacement as a function of time has been installed. This has altered the force versus displacement characteristics of the trigger somewhat.

Rifle Camera. A CCD camera is mounted at the front end of the barrel with its optical axis parallel to the line of fire and with a vertical offset of 1 inch. The camera is a SONY X-37 consisting of a CCD video array, a special 300 mm lens fabricated in-house, by NTSC, and a filter to block out extraneous light (other than infrared).

Rifle Sensing Instrumentation

The rifle sensing instrumentation consists of sensors to monitor parameters associated with rifle functioning to include rear sight selection, magazine insertion/extraction, semiautomatic/automatic firing mode, and trigger position.

Firing Selector Lever Position. A binary sensor indicates the "automatic" and "semiautomatic" positions of the selector lever.

Rear Sight Adjustment. A binary sensor indicates the selected position of the rear sight, either battlesight or long range.

Trigger Operation. A linear travel potentiometer is mounted with the rifle trigger. As the trigger is moved, the potentiometer produces a varying voltage that indicates the position of the trigger.

Magazine. A magazine insertion/extraction feature is provided for realism and monitored to prevent rifle firing when a magazine is not inserted. Each magazine contains a capacitor which when charged produces a current pulse as the magazine is inserted into the rifle. The pulse signals that a loaded magazine has been inserted. Once discharged, the magazine must be removed from the rifle and its capacitor recharged. If it is not recharged and the magazine is reinserted into the rifle, the magazine will register empty and the rifle will not fire. During firing, rounds remaining are monitored to limit firing to the number normally held by a magazine, e.g., 20 to 30 rounds for the large M16A1 magazines.

Shooter Feedback

Round Impact Display. An RGB monitor is used to show the shooter's aim point. The aiming point is shown before and after trigger squeeze. Before trigger squeeze, a cursor is displayed that moves as the aim point changes. The cursor is superimposed on a graphic representation of a target silhouette. After trigger squeeze, the aim and impact points at trigger squeeze are continuously displayed on the monitor.

Rifle Report. A pair of earphones, worn by the shooter, delivers the rifle report to the shooter's ears. The generation of the rifle report is described above.

Firing Platform

This component consists of an 8x5x3-foot rectangular stand. Two or more sandbags are located on top of the platform in front of the shooter to provide support for the TB rifle. Sandbags are also provided for the shooter to stand on to adjust the shooter's height so that targets can easily be observed on the target board. The stand allows the shooter to fire from the foxhole-supported and unsupported, the prone-supported and unsupported, and the standing positions.

TARGET BOARD

The target board is a scaled model of a shooting range. It consists of scaled E-type silhouette targets and landscaped terrain. Target scaling factors are based on the angle that would be subtended by a life-size silhouette (40" x 20") over the silhouette's actual distance from the shooter. The target board is illuminated by variable, high intensity lamps.

Target Simulation

Targets are E-type (man-shaped) silhouettes scaled to represent targets located at ranges from 50 to 300 meters. There are 9 targets. Five static pop-up targets move only vertically. They are located at the following scaled ranges: one at 50 meters, three at 250 meters, and one between the 180- and 250-meter ranges. This later target is for zeroing the rifle.

The remaining four targets move vertically and horizontally. They are located as follows: one at 60 meters, one at 120 meters, one at 180 meters, and one at 300 meters. Vertical motion is accomplished by a post-and-gear mechanism. Horizontal motion is accomplished by means of a sprocket-and-chain mechanism.

All of the moving targets move along a 6-foot track perpendicular to the shooter's line of sight. Target velocity and acceleration as well as vertical and lateral motions are microprocessor-controlled by individual stepper motors. Each motor is driven by a Darlington power amplifier. All of the drivers are interfaced to the computer system through a custom-made board consisting of a series of Cybernetics Microsystems CY512's for motor control. The target motion mechanism is housed underneath the terrain board.

Every target has an IRED mounted along its midline near the shoulder portion of the target. The IRED has a maximum power output of 12 milliwatts through a 1/16-inch diameter aperture. It emits at a peak wavelength of 880 nanometers. The IRED emissions are detected by the CCD video array in the camera mounted on the TB rifle.

Target Environment

The terrain board is 8 feet wide and 17 feet long. Its height varies from 5 to 6 feet. It is about the same height as the top of the firing platform. It slopes upwards slightly. Trees and bushes are not represented on the target board, only green grass is. The edge of the terrain board is located 20 feet from the firing platform. The terrain board is supported by a wooden structure. The terrain board is shown in Figure 4D.

EXPERIMENTER'S STATION

This station consists of an Intel ®86/380 computer system, experimenter interface, RGB graphics montior, and audio amplifier. These components are are arranged as shown in Figure 5D.

Intel ®86/380 Computer System

This system has the following compenents:

- Intel ®86/30 system controller board
- Intel ®86/14 graphics controller board
- Intel ®video graphics controller board
- Intel ®ISBC 88/40 analog interface board
- Stepper motor controller boards

System Controller Board. The 86/30 system controller board stores and retrieves data from either a 35-megabyte hard disk or an 8-inch floppy drive. It loads target movement scenarios onto the controller on the stepper motor controller board. It also performs rifle ballistics calculations. Additionally, at start-up, it displays menus which allow the experimenter to select the type of target to be displayed, the target range, the target speed (for moving targets), recoil and rifle report effects, target action on being hit, and the ballistic characteristics of the rifle/ammunition combination. In configuring the scenario required for a study, the experimenter uses only one or two keystrokes to select menu items.

Graphics And Video Controller Boards. An 86/14 graphics controller board controls the CCD camera system and two Matrox boards. One of these boards is a video frame grabber while the other generates graphics. Additionally, the 86/14 board draws the graphics presented on the RGB graphics monitor.

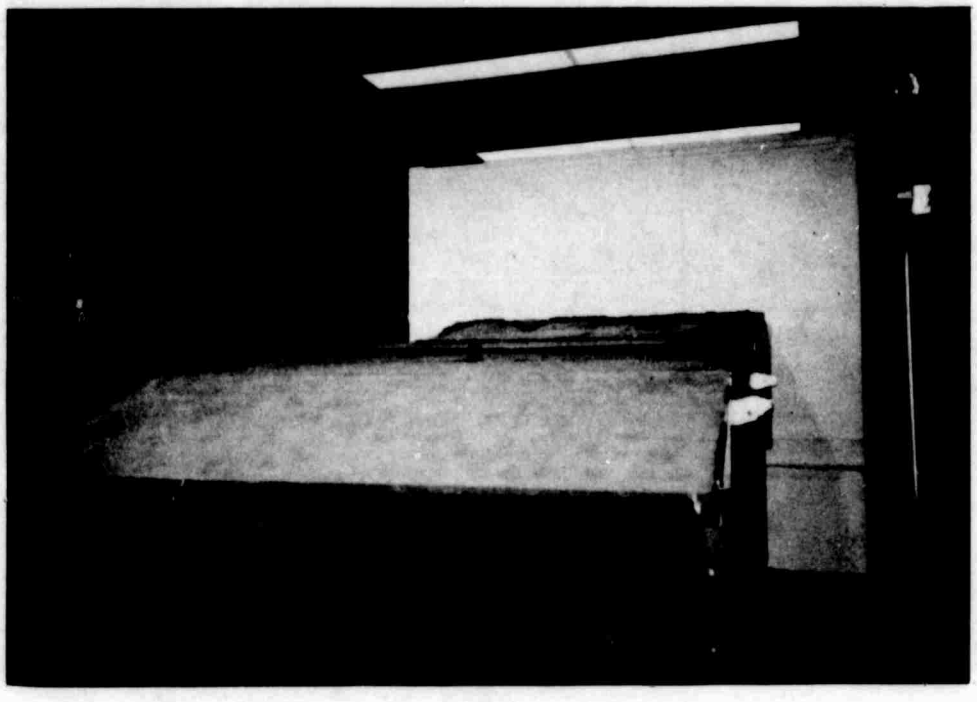

Figure 4D. Test Bed Target Board.

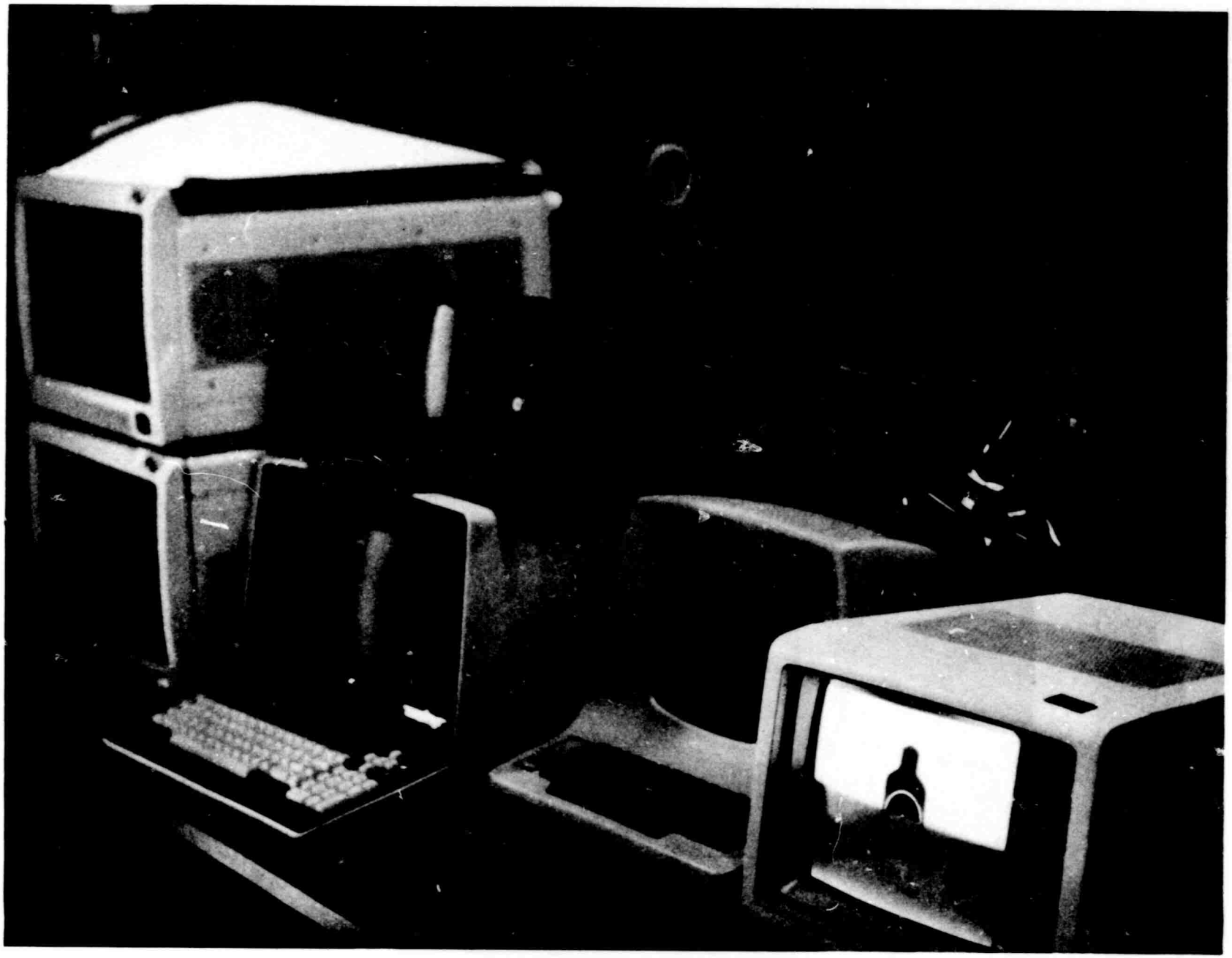

Figure 5D. Equipment layout for the Test Bed experimenter's station.

Shooter aim point and "bullet strike" are provided through an Intel R video graphics controller board. This board is installed on and interface with the 86/14 "host" microcomputer board. Communication between the two boards is supported by software in the host computer.

The main components of the video graphics board are a graphics display controller microcircuit and 32 kilobytes of random access display memory. The video board has the capability of reading and writing to the display memory using one of several preprogrammed algorithms which allow special shapes to be drawn very quickly.

Horizontal and vertical sync information for color raster are provided by the video graphics board after initialization. The raster consists of an array of 216 rows and 288 columns of dots or pixels. Each pixel has a corresponding base address in the video board's memory and can be set to any one of eight colors (black, red, blue, magenta, green, yellow, cyan, or white) by altering the contents of its memory location. Lines, arcs, and rectangles can be drawn by using special commands that activate preprogrammed algorithms on the video board. By drawing arcs, lines, and rectangles, target representations can be presented on the RGB monitor.

When the system is in operation, trajectory calculations are used to describe the location of "bullet strike" on the target. This location is converted to x and y coordinate pairs, passed to the host computer, and in turn to the video controller board. "Bullet strike" position is then displayed on the RGB monitor as a spot. This provides an instantaneous indication of where the shooter's "bullet" hit relative to target's center of mass.

Shooter tracking is displayed in a similar way. Data representative of the shooter's aim point are continuously taken prior to firing the TB rifle, passed through the host computer, and then on to the video controller board. This board then outputs to the RGB monitor a spot that shows the near real-time position of the shooter's aim point. Finally, at the time of firing, the shooter's aim point is displayed on the monitor.

Analog Interface Board. This board is an Intel® ISBC 88/40 single board measurement and control computer. It has onboard microcircuits for peripheral control, communications, and timer functions capable of performing analog to digital conversions. This board reads sensors on the TB rifle and controls the simulated recoil and rifle report sound effects.

The computer residing on this board functions as an I/O interface between the TB rifle and other TB components.

Logic levels from switches mounted in the TB rifle are sampled and stored by connecting outputs from the rifle to the peripheral interface on the 88/40 board. Analog signals such as trigger position are connected to the inputs of analog to digital converter. Two additional lines are also brought into the 88/40 board to provide interrupts signifying the exact time the trigger is pulled and when a new magazine is inserted into the TB rifle.

Rifle switches and potentiometers indicating the status of the trigger, the rear sight, and magazine insertion/extraction are monitored continuously until the trigger is snapped. This action generates an interrupt to the computer. Control signals are generated to provide a "bang" to the shooter through the headset along with recoil.

When a new magazine is inserted into the TB rifle, an interrupt is generated that initializes the magazine "round" count to 30 (31 if a round was already chambered).

Stepper Motor Controller Boards. Targets are under control of the host computer via two custom fabricated stepper motor controller boards. One board is dedicated to commanding the static pop-up targets, while the second board commands the moving targets. The two boards are interchangeable and capable of commanding 10 independent stepper motors.

Each target stepper motor is controlled by a Cybernetics Microsystems CY512. High-level commands are sent to the CY512 from the 86/30 system controller via an Intel® Universal Peripheral Interface (UPI). A pair of UPI chips is resident on each stepper motor controller board. Each UPI is programmed to route scenarios to the CY512 selected by the 86/30 controller. The scenarios consist of a stream of ASCII characters that command the CY512 to move the target. The CY512 then acts as a stand-alone device controlling the stepper motors in accordance with the system controller's scenario instructions.

One UPI is programmed to keep a count of the absolute position of each stepper motor (UPI-C). For each step completed, the CY512 ouputs an active low pulse which is monitored by UPI-C. This UPI maintains position by incrementing (positive direction) or decrementing (negative direction) a counter. The UPI's internal random access memory has 10 counters. The host computer can interrupt this UPI at any time to obtain a count or "position" of the motor selected.

Experimenter Interface

This component consists of a computer terminal (alphanumeric CRT and keyboard combination) interfaced to the Intel® 86/380 system. It allows the experimenter to initialize the TB system and select firing "scenarios" for the shooter (e.g., zero task, self-paced task, known distance task, or day defense scenario task), monitor shooter performance, and control the simulation.

RGB Graphics Monitor

This monitor displays the simulated rifle round impact points before and at this time of trigger squeeze.

Audio Amplifier

This amplifier consists of an Altec Lansing® Mixer/Preamp (Model 1692A), and an Altec Lansing ® Power amp, (Model 1269). The audio amplifier system is used to condition the rifle report signal before routing it to a pair of earphones worn by the shooter.

APPENDIX E

HEALTH HAZARD ASSESSMENT OF THE TB

AMCSG (3 Aug 84) 1st Ind
SUBJECT: Health Hazard Assessment of the Artificial Intelligence (AI) Research Test Bed

HQ, USAMC, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001 28 Aug 84

TO: HQDA (DASG-PSP-E, LTC McAlear), WASH DC 20310-2300

1. Reference:

a. AR 40-10, Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process, 15 Sep 83.

b. MIL-STD-1474B (MI), Military Standard, Noise Limits for Army Materiel, 18 Jun 79.

c. Telephone conversation between CPT (P) William T. Broadwater, Health Hazard Assessment Officer, AMCDE-S, and Dr. James Cronholm, PM TRADE, 27 Aug 84, subject as above.

d. Telephone conversation between CPT (P) William T. Broadwater, and Mr. Jim Franks, Laser Microwave Division, US Army Environmental Hygiene Agency, 27 Aug 84, subject as above.

2. The AMC Surgeon's Office has reviewed the supporting documentation for the request for a health hazard assessment of the AI Research Test Bed. This office concurs with PM TRADE's assessment that the potential ocular and auditory hazards identified for this system do not pose actual health hazards to users of the proposed AI Research Test Bed. This concurrence is based on a review of impulse noise standards (reference 1b) and coordination with USAEHA (reference 1c) concerning the potential ocular hazard. It should be noted, however, that there is a potential ocular hazard for maintenance personnel from the infrared emitting diode within 35 centimeters of the IR source. It is recommended that appropriate warning information be posted and enforced.

3. Request the Office of The Surgeon General (OTSG) review the draft Systems Concept Paper (Enc 1), in accordance with paragraph 3-2.b. (2) of AR 40-10, as well as information in Enclosures 2 through 4, to determine if the materiel developer's assessment is valid. Concurrence or further guidance is needed no later than 7 Sep 84 so that an OTSG position can be provided to HQ TRADOC prior to test initiation.

4. Point of Contact for this headquarters is CPT (P) William T. Broadwater, Health Hazard Assessment Officer, AMCDE-S 274-9851.

FOR THE COMMANDER:

/s/ T. Nowosiwsky
TARAS NOWOSIWSKY, M.D.
Colonel, MC
Command Surgeon

4 Encl
nc

CF:
AMCPM-TND-SP (w/o encls)
HSHB-OA
SGRD-PLC

APPENDIX F

HUMAN FACTORS QUESTIONNAIRE

HUMAN FACTORS TEST SOLDIER QUESTIONNAIRE
DIRECT FIRE WEAPONS TEST BED

NAME:_____ DATE:_____

INSTRUCTIONS: Since you have been involved in the testing of the M16A1 Direct Fire Marksmanship Test Bed, your opinions are very important. Please answer each question below, using the scale provided, and write any comments you desire. If you are not certain what a particular question means, please ask for help.

1. Compared to the real M16A1 rifle, operating the charging handle on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

2. Compared to the real M16A1 rifle, operating the selector switch on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

3. Compared to the real M16A1 rifle, loading a magazine into the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

4. Compared to the real M16A1 rifle, unloading a magazine from the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

5. Compared to the real M16A1 rifle, operating the trigger on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

6. Compared to the real M16A1 rifle, the amount of pressure required to squeeze the trigger on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

7. Compared to the real M16A1 rifle, adjusting the front sight post on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

8. Compared to the real M16A1 rifle, adjusting the rear peep sight on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

9. Compared to the real M16A1 rifle, obtaining a good stock weld on the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

10. Compared to the real M16A1 rifle, assuming a good comfortable standing semisupported firing position with the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

11. Compared to the real M16A1 rifle, the amount of recoil produced by the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

12. Compared to the real M16A1 rifle, the noise level produced by the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

13. Compared to the real M16A1 rifle, aiming (placing the front sight post on the target) the Test Bed rifle was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

14. Compared to real targets, seeing the stationary Test Bed targets was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

15. Compared to real targets, hitting stationary Test Bed targets was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments: _____

_____

16. Compared to real targets, seeing moving Test Bed targets was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments: _____

_____

17. Compared to real targets, hitting moving Test Bed targets was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments: _____

_____

18. Compared to real targets, the contrast of Test Bed targets was:

5	4	3	2	1
Very Good	Good	Borderline	Poor	Very Poor

Comments: _____

_____

19. Compared to a real rifle range, the size of the targets on the Test Bed was:

5	4	3	2	1
Very Good	Good	Borderline	Poor	Very Poor

Comments: _____

_____

20. The lighting of the Test Bed environment was:

5	4	3	2	1
Very Good	Good	Borderline	Poor	Very Poor

Comments: _____

_____

21. Compared to real targets, the amount of time it took for Test Bed targets to rise up was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

22. Compared to real targets, the amount of time it took for Test Bed targets to fall was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

23. Compared to real targets, the rate at which slow moving Test Bed targets moved was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

24. Compared to real targets, the rate at which fast moving Test Bed targets moved was:

5	4	3	2	1
Very Similar	Similar	Borderline	Different	Very Different

Comments:_____

_____

25. Was there any aspect of the Test Bed that may have <u>hindered</u> your performance on the zeroing task?

_____ No

_____ Yes Explain:_____

_____

26. Was there any aspect of the Test Bed that may have helped your performance on the zeroing task?

_____ No

_____ Yes Explain:_____

_____

27. Overall, the Test Bed zeroing task was:

5	4	3	2	1
Very Good	Good	Borderline	Poor	Very Poor

Comments:_____

_____

28. Compared to your field zeroing task performance, how would you rate your Test Bed zeroing task performance?

5	4	3	2	1
Much Better	Better	About The Same	Worse	Much Worse

Comments:_____

_____

29. Was there any aspect of the Test Bed that may have hindered your performance on the self-paced firing task?

_____ No

_____ Yes Explain:_____

_____

30. Was there any aspect of the Test Bed that may have helped your performance on the self-paced firing task?

_____ No

_____ Yes Explain:_____

_____

31. Overall, the Test Bed self-paced firing task was:

5	4	3	2	1
Very Good	Good	Borderline	Poor	Very Poor

Comments:_____

_____

32. Compared to your field self-paced firing task, how would you rate your Test Bed self-paced firing task?

5	4	3	2	1
Much Better	Better	About The Same	Worse	Much Worse

Comments:_____

_____

33. Was there any aspect of the Test Bed that may have hindered your performance on the target scenario task?

_____ No

_____ Yes Explain:_____

_____

34. Was there any aspect of the Test Bed that may have helped your performance on the target scenario task?

_____ No

_____ Yes Explain:_____

_____

APPENDIX G

ROTC GROUP WAIVER FORMS

WAIVER OF CAUSE OF ACTION AND/OR CLAIM

For and in consideration of being permitted to participate in the validation test portion of the Artificial Intelligence (AI) Research Test Bed program of the Government of the United States, through its agents, the Departments of the Army and of the Navy -- which program and student participation therein are more fully described in the attached summary -- I, _____, expressly agree to waive any cause of action and/or claim against the Government of the United States, including any agents instrumentalities, officials, or employees thereof, for or on account of the death of or injury to myself while engaged in any activity in connection with the AI Research Test Program, including traveling to or from any government facility, installation, or other Government-controlled sites of Program activity to or from any other point.

It is understood and agreed by the undersigned that this document may be pleaded as a complete defense to any action or other proceeding which may be brought by me, my heirs, or my legal representatives against the Government of the United States, including any agents, instrumentalities, officials, or employees thereof.

_____
(Participating Student)

_____
(Street)

_____
(City, state, zip)

_____
(Date)

TRAINING STUDY

The Training Study is scheduled to begin toward the end of October or during the first part of November 1984. It will involve 20 students enrolled in a Reserve Officer Training Corps (ROTC) program in the Orlando, Florida area. All will be volunteers. They will complete a version of the U.S. Army's basic rifle marksmanship (BRM) training program. Specific training tasks will include:

Apply fundamentals of steady position, aiming, breath control, and trigger control to minimize weapon movement during firing.

Zero the M16 rifle.

Engage single static and moving targets.

Most of the training will take place at the Artificial Intelligence Test Bed, N73, Naval Training Equipment Center (NAVTRAEQUIPCEN). This training system provides a non-hazardous environment in which to learn to fire the M16A1 rifle. Some preliminary training involving rifle fundamentals will be completed on a not to interfere basis with the students' classes at school. It is expected that 3 to 4 afternoon or evening sessions for about 3 hours per session will be needed for training.

Training will be conducted by PM TRADE and N73 personnel. Prior to training the students will be given a list of rules defining their conduct and duties during the study. They will be briefed on the rules and questions about the rules will then be answered. While training, the students will be constantly monitored by Government personnel. Students who fail to abide by the rules of conduct will be immediately dropped from the training.

Following training in Orlando, the students will travel to Fort Benning, Georgia at the Government's expense under Government supervision. Here they will complete live firing in exercises on U.S. Army Infantry Board (USAIB) firing ranges. This part of the study will take about 2 days to complete including travel to and from Fort Benning.

Before shooting any live rounds, the students will be briefed by experienced riflemen on rifle and range safety. During all firing the students will be under the supervision of experienced USAIB riflemen. The rules defining student conduct and duties will also be in effect during the range firing at Fort Benning.

All student travel, lodging, and subsistence will be arranged by PM TRADE personnel. All travel to and from N-73 will be by privately owned vehicles. Students will be given a training schedule and the appropriate passes to come aboard the NAVTRAEQUIPCEN. Travel to and from Fort Benning. Lodging in the Fort Benning area, and meals will be coordinated by PM TRADE in conjucntion with represetatives from the USAIB and the U.S. Army Infantry School at Fort Benning.

COVENANT NOT TO SUE - PRACTICAL FIELD TRAINING

STATEMENT REQUIRED BY PRIVACY ACT OF 1974

1. AUTHORITY: Title 10, U.S. Code 2102.

2. PRINICPAL PURPOSE(S): A statement releasing US Government from liability for injury, death, or damanges for ROTC cadets participating in Voluntary Off-Campus Training programs.

3. ROUTINE USES: Normal Personnel Actions. Disclosures of information may be provided to proper authorities in actions regarding law enforcement, legal actions as a result of injury or death, and investigations of accidents resulting from such Voluntary Off-Campus Training.

4. MANDATORY OR VOLUNTARY DISCLOSURE AND EFFECT ON INDIVIDUAL NOT PROVIDING INFORMATION: Disclosure is voluntary. Fairlure of cadet to complete form will disqualify ROTC cadet from participating in that specific voluntary Off-Campus Training Exercise.

I,_____, residing at _____
(Type or print full name)
_____ do hereby agree that in consideration for being
(Address, City, State)
allowed to participate in _____
(Type of Training)
conducted by _____ Army ROTC detachment, and
(Name of ROTC Instructor Group)
Army supervised activity, and whereas I am doing so entirely on my own initiative, risk, and responsibility; now therefore in consideration of the permission extended to me by the United States Army, the State of _____
(Name of state school located)
and_____ through their officers and agents to take
(Name of Institution)
part in such activity, I do hereby, for myself, my heirs, executors, assigns, and administrators, remise, release, and forever discharge the Government of the United States, the State of _____, and _____
(Name of state school located) (Name of Institution)
and all of its officers, agents, and employees, acting officially or otherwise, from any and all claims, demands, actions, or causes of action, on account of my death or on account of injury to me which may occur from any cause during said activity or continuances thereof; and I do further convenant and agree to hold the said Government of the United States, the state of _____, and
(Name of state school located)

_____ blameless for any and all damage which
(Name of Institution)
I may cause either intentionally or through my negligence.

_____ _____
Signature of Parent or Guardian, if a minor | Signature of Cadet

_____ _____
Typed/Printed Name of Parent or Guardian, if a minor | Typed/Printed Name of Cadet

_____ _____
Relationship to Cadet | Age/Period Covered/Activity

_____
Date

WITNESS:

_____

_____

APPENDIX H

SUMMARY ANALYSIS OF VARIANCE TABLES FOR PRODUCT MEASURES OF MARKSMANSHIP PERFORMANCE

TABLE OF CONTENTS

TABLE 1H

Summary Analysis of Variance for Number of Rounds to Zero in Test Bed and Field (Parametric Experiment)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	399.18103	1	399.18103	0.91	0.3482
Error	11823.75000	27	437.91667		
Treatment (T)	26.39483	1	26.39483	0.10	0.7497
T x G	143.70517	1	143.70517	0.57	0.4586
Error	6862.95000	27	254.18333		

TABLE 2H

Summary Analysis of Variance For Self-Paced Task Group Diameter in Test Bed and Field (Parametric Experiment)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	1023.64212	1	1023.64212	0.28	0.6038
Error	100252.97857	27	3713.07328		
Treatment (T)	5148.65033	1	5148.65033	2.19	0.1503
T x G	976.65033	1	976.65033	0.42	0.5245
Error	63409.07381	27	2348.48422		

TABLE 3H

Summary Analysis of Variance For Self-Paced
Task SD of Aiming Accuracy for Test Bed and Field
(Parametric Experiment)

urce	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
oup (G)	3.21872	1	3.21872	0.01	0.9068
ror	6228.05714	27	230.66878		
eatment (T)	58.48407	1	58.48407	0.40	0.5322
x G	7.58752	1	7.58752	0.05	0.8214
ror	3943.89524	27	146.07019		

TABLE 4H

Summary Analysis of Variance For Self-Paced
Task Number of Hits on Target Silhouette for Test Bed and Field
(Parametric Experiment)

urce	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
oup (G)	1.40895	1	1.40895	0.93	0.3444
ror	41.07381	27	1.52125		
eatment (T)	2.28974	1	2.28974	1.14	0.2955
x G	3.18629	1	3.18629	1.58	0.2190
ror	54.33095	27	2.01226		

TABLE 5H

Summary Analysis of Variance for Proportion of Static Targets Engaged for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.04095	1	0.04095	0.98	0.3314
Error	1.13012	27	0.04186		
Treatment (T)	0.03847	1	0.03847	1.76	0.1962
T x G	0.00194	1	0.00194	0.09	0.7682
Error	0.59135	27	0.02190		
Range (R)	1.34616	4	0.33654	28.78	0.0000
R x G	0.08140	4	0.02035	1.74	0.1464
Error	1.26285	108	0.01169		
T x R	0.02730	4	0.00682	0.56	0.6947
T x R x G	0.02998	4	0.00749	0.61	0.6555
Error	1.32437	108	0.01226		
Exposure Time (E)	2.74795	2	1.37397	73.15	0.0000
E x G	0.11653	2	0.05827	3.10	0.0531
Error	1.01431	54	0.01878		
T x E	0.01799	2	0.00899	0.56	0.5723
T x E x G	0.03076	2	0.01538	0.96	0.3878
Error	0.86138	54	0.01595		
R x E	1.29725	8	0.16216	15.86	0.0000
R x E x G	0.06276	8	0.00785	0.77	0.6317
Error	2.20773	216	0.01022		
T x R x E	0.13212	8	0.01652	1.66	0.1086
T x R x E x G	0.03634	8	0.00454	0.46	0.8848
Error	2.14399	216	0.00993		

TABLE 6H

Summary Analysis of Variance for Proportion
of Static Targets Hit for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.72123	1	0.72123	3.92	0.0581
Error	4.97021	27	0.18408		
Treatment (T)	0.23378	1	0.23378	2.66	0.1146
T x G	0.07030	1	0.07030	0.80	0.3792
Error	2.37478	27	0.08795		
Range (R)	41.56125	4	10.39031	287.09	0.0000
R x G	0.05410	4	0.01353	0.37	0.8269
Error	3.90867	108	0.03619		
T x R	0.23507	4	0.05877	1.59	0.1811
T x R x G	0.10033	4	0.02508	0.68	0.6070
Error	3.98108	108	0.03686		
Exposure Time (E)	18.23508	2	9.11754	235.43	0.0000
E x G	0.13048	2	0.06524	1.68	0.1951
Error	2.09130	54	0.03873		
T x E	0.03943	2	0.01971	0.81	0.4486
T x E x G	0.05616	2	0.02808	1.16	0.3215
Error	1.30853	54	0.02423		
R x E	4.28811	8	0.53601	22.07	0.0000
R x E x G	0.30139	8	0.03767	1.55	0.1410
Error	5.24504	216	0.02428		
T x R x E	0.50914	8	0.06364	3.76	0.0004
T x R x E x G	0.22740	8	0.02843	1.68	0.1050
Error	3.65823	216	0.01694		

TABLE 7H

Summary Analysis of Variance for Number of Rounds Fired Per Static Target for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	10.46654	1	10.46654	5.81	0.0236
Error	45.04813	25	1.80193		
Treatment (T)	117.15473	1	117.15473	54.95	0.0000
T x G	17.63045	1	17.63045	8.27	0.0081
Error	53.30357	25	2.13214		
Range (R)	6.63542	4	1.65886	5.67	0.0004
R x G	8.38563	4	2.09641	7.17	0.0000
Error	29.23756	100	0.29238		
T x R	2.50874	4	0.62718	2.60	0.0403
T x R x G	3.65785	4	0.91446	3.80	0.0065
Error	24.08235	100	0.24082		
Exposure Time (E)	72.64116	2	36.32458	251.02	0.0000
E x G	0.48003	2	0.24001	1.66	0.2007
Error	7.23534	50	0.14471		
T x E	11.41399	2	5.70699	33.75	0.0000
T x E x G	1.52716	2	0.76358	4.52	0.0157
Error	8.45487	50	0.16910		
R x E	34.26639	8	4.28330	45.28	0.0000
R x E x G	0.86968	8	0.10871	1.15	0.3321
Error	18.91907	200	0.09460		
T x R x E	6.04545	8	0.75568	8.00	0.0000
T x R x E x G	0.71898	8	0.08987	0.95	0.4753
Error	18.89021	200	0.09445		

TABLE 8H

Summary Analysis of Variance for Proportion
of First Round Hits for Static Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.49810	1	0.49810	2.60	0.1186
Error	5.17610	27	0.19171		
Treatment (T)	2.20935	1	2.20935	17.69	0.0003
T x G	0.38534	1	0.38534	3.08	0.0904
Error	3.37277	27	0.12492		
Range (R)	55.28630	4	13.82158	324.83	0.0000
R x G	0.18732	4	0.04683	1.10	0.3601
Error	4.59537	108	0.04255		
T x R	0.50181	4	0.12545	2.99	0.0220
T x R x G	0.12723	4	0.03181	0.76	0.5548
Error	4.53133	108	0.04196		
Exposure Time (E)	4.03840	2	2.01920	68.33	0.0000
E x G	0.16369	2	0.08184	2.77	0.0716
Error	1.59583	54	0.02955		
T x E	0.89855	2	0.44928	13.30	0.0000
T x E x G	0.04708	2	0.02354	0.70	0.5025
Error	1.82392	54	0.03378		
R x E	0.85065	8	0.10633	3.91	0.0002
R x E x G	0.19790	8	0.02474	0.91	0.5091
Error	5.87304	216	0.02719		
T x R x E	1.11216	8	0.13902	6.06	0.0000
T x R x E x G	0.26375	8	0.03297	1.44	0.1825
Error	4.95623	216	0.02295		

TABLE 9H

Summary Analysis of Variance for Proportion of Moving Targets Engaged for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.00094	1	0.00094	0.09	0.7707
Error	0.29413	27	0.01089		
Treatment (T)	0.00527	1	0.00527	0.37	0.5493
T x G	0.03329	1	0.03329	2.32	0.1391
Error	0.38679	27	0.01433		
Range (R)	0.04822	2	0.02411	2.78	0.0707
R x G	0.00512	2	0.00256	0.30	0.7454
Error	0.46758	54	0.00866		
T x R	0.10727	2	0.05363	5.97	0.0045
T x R x G	0.02322	2	0.01161	1.29	0.2830
Error	0.48504	54	0.00898		
Speed (S)	0.00454	1	0.00454	0.68	0.4161
S x G	0.00094	1	0.00094	0.14	0.7092
Error	0.17955	27	0.00665		
T x S	0.01108	1	0.01108	1.97	0.1722
T x S x G	0.00103	1	0.00103	0.18	0.6729
Error	0.15217	27	0.00564		
R x S	0.00496	2	0.00248	0.70	0.4999
R x S x G	0.00209	2	0.00104	0.30	0.7452
Error	0.19080	54	0.00353		
T x R x S	0.00921	2	0.00461	1.47	0.2399
T x R x S x G	0.00849	2	0.00425	1.35	0.2674
Error	0.16967	54	0.00314		
Exposure Time (E)	0.12148	1	0.12148	17.82	0.0002
E x G	0.00295	1	0.00295	0.43	0.5165
Error	0.18402	27	0.00682		
T x E	0.00192	1	0.00192	0.20	0.6560
T x E x G	0.01054	1	0.01054	1.11	0.3005
Error	0.25544	27	0.00946		
R x E	0.07456	2	0.03728	6.58	0.00[illegible]8
R x E x G	0.00559	2	0.00280	0.49	0.613[illegible]
Error	0.30583	54	0.00566		
T x R x E	0.01994	2	0.00997	1.72	0.1884
T x R x E x G	0.00054	2	0.00027	0.05	0.9541
Error	0.31267	54	0.00579		
S x E	0.03187	1	0.03187	5.34	0.0287
S x E x G	0.00170	1	0.00170	0.28	0.5983
Error	0.16120	27	0.00597		
T x S x E	0.00454	1	0.00454	1.43	0.2426
T x S x E x G	0.00094	1	0.00094	0.30	0.5901
Error	0.08580	27	0.00318		
R x S x E	0.00516	2	0.00258	0.57	0.5685
R x S x E x G	0.00085	2	0.00042	0.09	0.9105
Error	0.24412	54	0.00452		

TABLE 10H

Summary Analysis of Variance for Proportion of Moving Targets Hit for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.04297	1	0.04297	0.14	0.7105
Error	8.24205	27	0.30526		
Treatment (T)	1.09332	1	1.09332	4.84	0.0366
T x G	0.01250	1	0.01250	0.06	0.8158
Error	6.10406	27	0.22608		
Range (R)	24.13926	2	12.06963	191.73	0.0000
R x G	0.05593	2	0.02796	0.44	0.6437
Error	3.39936	54	0.06295		
T x R	0.28431	2	0.14215	2.62	0.0823
T x R x G	0.16793	2	0.08396	1.55	0.2224
Error	2.93318	54	0.05432		
Speed (S)	2.97353	1	2.97353	62.20	0.0000
S x G	0.00047	1	0.00047	0.01	0.9221
Error	1.29066	27	0.04780		
T x S	0.04189	1	0.04189	0.72	0.4043
T x S x G	0.01136	1	0.01136	0.19	0.6625
Error	1.57538	27	0.5835		
R x S	0.27680	2	0.13840	4.27	0.0190
R x S x G	0.12162	2	0.06081	1.88	0.1631
Error	1.75104	54	0.03243		
T x R x S	0.08420	2	0.04210	1.05	0.3566
T x R x S x G	0.11581	2	0.05790	1.45	0.2445
Error	2.16275	54	0.04005		
Exposure Time (E)	6.69551	1	6.69551	140.07	0.0000
E x G	0.04572	1	0.04572	0.96	0.3367
Error	1.29066	27	0.04780		
T x E	1.01545	1	1.01545	22.60	0.0001
T x E x G	0.01221	1	0.01221	0.27	0.6064
Error	1.21318	27	0.04493		
R x E	1.11701	2	0.55850	13.72	0.0000
R x E x G	0.11269	2	0.5635	1.38	0.2592
Error	2.19747	54	0.04069		
T x R x E	0.04082	2	0.02041	0.57	0.5695
T x R x E x G	0.23047	2	0.11524	3.21	0.0481
Error	1.93745	54	0.03588		
S x E	0.01728	1	0.01728	0.58	0.4515
S x E x G	0.00111	1	0.00111	0.04	0.8477
Error	0.79900	27	0.02959		
T x S x E	0.06142	1	0.06142	2.68	0.1134
T x S x E x G	0.00216	1	0.00216	0.09	0.7616
Error	0.61943	27	0.02294		
R x S x E	0.12663	2	0.06332	2.00	0.1446
R x S x E x G	0.22577	2	0.11288	3.57	0.0349
Error	1.70580	54	0.03159		
T x R x S x E	0.08935	2	0.04468	1.13	0.3318
T x R x S x E x G	0.11952	2	0.05976	1.51	0.2309
Error	2.14251	54	0.03968		

TABLE 11H

Summary Analysis of Variance for Number of Rounds Fired Per Moving Target for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	10.31117	1	10.31117	4.74	0.0391
Error	54.35338	25	2.17414		
Treatment (T)	40.43519	1	40.43519	26.18	0.0000
T x G	6.91782	1	6.91782	4.48	0.0444
Error	38.60899	25	1.54436		
Range (R)	4.68080	2	2.34040	7.71	0.0012
R x G	3.94817	2	1.97408	6.51	0.0031
Error	15.17259	50	0.30345		
T x R	0.98225	2	0.49113	2.35	0.1056
T x R x G	0.93943	2	0.46971	2.25	0.1160
Error	10.43827	50	0.20877		
Speed (S)	27.26687	1	27.26687	122.58	0.0000
S x G	0.00028	1	0.00028	0.00	0.9720
Error	5.56126	25	0.22245		
T x S	0.29572	1	0.29572	1.33	0.2599
T x S x G	0.13947	1	0.13947	0.63	0.4360
Error	5.56366	25	0.22255		
R x S	1.41370	2	0.70685	3.74	0.0306
R x S x G	0.18029	2	0.09014	0.48	0.6233
Error	9.44394	50	0.18888		
T x R x S	0.99368	2	0.49684	5.35	0.0078
T x R x S x G	0.18465	2	0.09232	0.99	0.3771
Error	4.64174	50	0.09283		
Exposure Time (E)	83.56134	1	83.56134	221.49	0.0000
E x G	0.82407	1	0.82407	2.18	0.1519
Error	9.43191	25	0.37728		
T x E	4.79182	1	4.79182	22.78	0.0001
T x E x G	1.78835	1	1.78835	8.50	0.0074
Error	5.25814	25	0.21033		
R x E	20.99373	2	10.49687	87.97	0.0000
R x E x G	0.18239	2	0.09119	0.76	0.4710
Error	5.96615	50	0.11932		
T x R x E	0.41833	2	0.20917	1.63	0.2069
T x R x E x G	0.02829	2	0.01414	0.11	0.8961
Error	6.43043	50	0.12861		
S x E	1.88303	1	1.88303	11.48	0.0023
S x E x G	0.00224	1	0.00224	0.01	0.9079
Error	4.10212	25	0.16408		
T x S x E	0.41695	1	0.41695	3.28	0.0821
T x S x E x G	0.00298	1	0.00298	0.02	0.8795
Error	3.17584	25	0.12703		
R x S x E	0.20300	2	0.10150	0.58	0.5653
R x S x E x G	0.17175	2	0.08587	0.49	0.6166
Error	8.79507	50	0.17590		
T x R x S x E	0.39074	2	0.19537	1.52	0.2278
T x R x S x E x G	0.99684	2	0.49842	3.89	0.0270
Error	6.41057	50	0.12821		

TABLE 12H

Summary Analysis of Variance for Proportion
of First Round Hits for Moving Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.14885	1	0.14885	0.43	0.5198
Error	9.45064	27	0.35002		
Treatment (T)	0.77702	1	0.77702	7.85	0.0093
T x G	0.06437	1	0.06437	0.65	0.4271
Error	2.67341	27	0.09902		
Range (R)	15.79241	2	7.89620	104.01	0.0000
R x G	0.02229	2	0.01115	0.15	0.8638
Error	4.09965	54	0.07592		
T x R	0.08974	2	0.04487	0.79	0.4611
T x R x G	0.16014	2	0.08007	1.40	0.2551
Error	3.08537	54	0.05714		
Speed (S)	6.88293	1	6.88293	81.54	0.0000
S x G	0.07258	1	0.07258	0.86	0.3620
Error	2.27907	27	0.08441		
T x S	0.31774	1	0.31774	5.37	0.0283
T x S x G	0.01745	1	0.01745	0.30	0.5915
Error	1.59678	27	0.05914		
R x S	0.61767	2	0.30883	8.14	0.0008
R x S x G	0.07456	2	0.03728	0.98	0.3809
Error	2.04846	54	0.03793		
T x R x S	0.28528	2	0.14264	3.84	0.0275
T x R x S x G	0.26660	2	0.13330	3.59	0.0343
Error	2.00441	54	0.03712		
Exposure Time (E)	0.05728	1	0.05728	1.92	0.1772
E x G	0.04004	1	0.04004	1.34	0.2568
Error	0.80551	27	0.02983		
T x E	0.00154	1	0.00154	0.03	0.8616
T x E x G	0.00154	1	0.00154	0.03	0.8616
Error	1.34077	27	0.04966		
R x E	0.20266	2	0.10133	2.68	0.0774
R x E x G	0.09274	2	0.04637	1.23	0.3008
Error	2.03854	54	0.03775		
T x R x E	0.05210	2	0.02605	0.59	0.5606
T x R x E x G	0.04133	2	0.02066	0.46	0.6312
Error	2.40461	54	0.04453		
S x E	0.00134	1	0.00134	0.03	0.8750
S x E x G	0.00134	1	0.00134	0.03	0.8750
Error	1.43472	27	0.05314		
T x S x E	0.26418	1	0.26418	5.79	0.0233
T x S x E x G	0.00556	1	0.00556	0.12	0.7299
Error	1.23259	27	0.04565		
R x S x E	0.16913	2	0.08457	2.22	0.1183
R x S x E x G	0.21439	2	0.10720	2.82	0.0687
Error	2.05590	54	0.03807		
T x R x S x E	0.04816	2	0.02408	0.54	0.5870
T x R x S x E x G	0.00290	2	0.00145	0.03	0.9568
Error	2.41682	54	0.04476		

TABLE 13H

Summary Analysis of Variance for Number of Rounds to Zero in Test Bed and Field (Training Experiment)

(A) ROTC Group's First Zero

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	1439.19737	2	719.59868	1.45	0.2480
Error	17353.75000	35	495.82143		
Treatment (T)	1352.83025	1	1352.83025	4.18	0.0486
T x G	3215.57632	2	1607.78816	4.96	0.0127
Error	11336.95000	35	323.91286		

(B) ROTC Group's Last Zero

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	1462.68421	2	731.34211	2.02	0.1480
Error	12679.75000	35	362.27857		
Treatment (T)	163.72197	1	163.72197	0.75	0.3935
T x G	232.74737	2	116.37368	0.53	0.5929
Error	7676.95000	35	219.34143		

TABLE 14H

Summary Analysis of Variance for Self-Paced
Task Group Diameter in Test Bed and Field
(Training Experiment)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	8408.32698	2	4204.16349	1.01	0.3729
Error	144992.42302	35	4142.64066		
Treatment (T)	1555.74183	1	1555.74183	0.55	0.4639
T x G	25610.19666	2	12805.09833	4.51	0.0180
Error	99269.18492	35	2836.26243		

TABLE 15H

Summary Analysis of Variance for Self-Paced
Task SD of Aiming Accuracy for Test Bed and Field
(Training Experiment)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	478.66947	2	239.33473	0.96	0.3939
Error	8754.50159	35	250.12862		
Treatment (T)	332.32061	1	332.32061	2.02	0.1640
T x G	1237.35769	2	618.67884	3.76	0.0331
Error	5754.33968	35	164.40971		

TABLE 16H

Summary Analysis of Variance for Self-Paced
Task Number of Hits on Target Silhouette for Test Bed and Field
(Training Experiment)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	2.34140	2	1.17070	0.60	0.5539
Error	68.18492	35	1.94814		
Treatment (T)	0.20019	1	0.20019	0.10	0.7549
T x G	11.17197	2	5.58599	2.76	0.0769
Error	70.77540	35	2.02215		

TABLE 17H

Summary Analysis of Variance for Proportion
of Static Targets Engaged for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.07501	2	0.03751	1.51	0.2342
Error	0.86734	35	0.02478		
Range (R)	0.51650	4	0.12912	13.51	0.0000
R x G	0.22037	8	0.02755	2.88	0.0053
Error	1.33801	140	0.00956		
Exposure Time (E)	1.21221	2	0.60610	40.50	0.0000
E x G	0.13051	4	0.03263	2.18	0.0800
Error	1.04746	70	0.01496		
R x E	0.80390	8	0.10049	9.54	0.0000
R x E x G	0.20473	16	0.01280	1.21	0.2560
Error	2.95063	280	0.01054		

TABLE 18H

Summary Analysis of Variance for Proportion
of Static Targets Hit for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.69042	2	0.34521	2.30	0.1147
Error	5.24213	35	0.14978		
Range (R)	28.59685	4	7.14921	194.74	0.0000
R x G	0.20648	8	0.02581	0.70	0.6884
Error	5.13972	140	0.03671		
Exposure Time (E)	8.95081	2	4.47541	228.27	0.0000
E x G	0.11053	4	0.02763	1.41	0.2398
Error	1.37241	70	0.01961		
R x E	2.62344	8	0.32793	16.49	0.0000
R x E x G	0.54425	16	0.03402	1.71	0.0442
Error	5.56686	280	0.01988		

TABLE 19H

Summary Analysis of Variance for Number of Rounds Fired Per Static Target for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	27.86209	2	13.93105	32.27	0.0000
Error	15.10891	35	0.43168		
Range (R)	13.41626	4	3.35407	38.04	0.0000
R x G	7.75998	8	0.97000	11.00	0.0000
Error	12.34479	140	0.08818		
Exposure Time (E)	33.07229	2	16.53614	208.46	0.0000
E x G	4.24760	4	1.06190	13.39	0.0000
Error	5.55289	70	0.07933		
R x E	15.81915	8	1.97739	39.48	0.0000
R x E x G	2.61203	16	0.16325	3.26	0.0000
Error	14.02560	280	0.05009		

TABLE 20H

Summary Analysis of Variance for Proportion of First Round Hits for Static Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	2.68460	2	1.34230	8.69	0.0009
Error	5.40862	35	0.15453		
Range (R)	34.34981	4	8.58745	238.79	0.0000
R x G	0.29088	8	0.03636	1.01	0.4305
Error	5.03475	140	0.03596		
Exposure Time (E)	2.36923	2	1.18461	50.79	0.0000
E x G	1.15390	4	0.28848	12.37	0.0000
Error	1.63255	70	0.02332		
R x E	0.82467	8	0.10308	4.16	0.0001
R x E x G	0.63813	16	0.03988	1.61	0.0653
Error	6.93215	280	0.02476		

TABLE 21H

Summary Analysis of Variance for Proportion of Moving Targets Engaged for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.03772	2	0.01886	1.32	0.2795
Error	0.49915	35	0.01426		
Range (R)	0.03201	2	0.01601	1.23	0.2979
R x G	0.06816	4	0.01704	1.31	0.2741
Error	0.90936	70	0.01299		
Speed (S)	0.02707	1	0.02707	4.15	0.0493
S x G	0.03101	2	0.01550	2.38	0.1078
Error	0.22845	35	0.00653		
R x S	0.01257	2	0.00628	1.28	0.2858
R x S x G	0.00539	4	0.00135	0.27	0.8942
Error	0.34494	70	0.00493		
Exposure Time (E)	0.03114	1	0.03114	4.37	0.0438
E x G	0.00812	2	0.00406	0.57	0.5707
Error	0.24915	35	0.00712		
R x E	0.01586	2	0.00793	1.36	0.2633
R x E x G	0.10554	4	0.02638	4.52	0.0026
Error	0.40817	70	0.00583		
S x E	0.01139	1	0.01139	2.91	0.0967
S x E x G	0.00316	2	0.00158	0.40	0.6706
Error	0.13678	35	0.00391		
R x S x E	0.01587	2	0.00793	1.38	0.2585
R x S x E x G	0.07704	4	0.01926	3.35	0.0145
Error	0.40268	70	0.00575		

TABLE 22H

Summary Analysis of Variance for Proportion of Moving Targets Hit for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.09913	2	0.04956	0.15	0.8594
Error	11.39772	35	0.32565		
Range (R)	15.69825	2	7.84913	140.67	0.0000
R x G	0.43740	4	0.10935	1.96	0.1102
Error	3.90580	70	0.05580		
Speed (S)	1.08344	1	1.08344	22.77	0.0000
S x G	0.05087	2	0.02543	0.53	0.5906
Error	1.66528	35	0.04758		
R x S	0.15523	2	0.07762	1.52	0.2268
R x S x G	0.15735	4	0.03934	0.77	0.5496
Error	3.58497	70	0.05121		
Exposure Time (E)	1.76773	1	1.76773	54.29	0.0000
E x G	0.06334	2	0.03167	0.97	0.3881
Error	1.13965	35	0.03256		
R x E	0.26565	2	0.13282	4.21	0.0188
R x E x G	0.41430	4	0.10357	3.28	0.0159
Error	2.20961	70	0.03157		
S x E	0.00760	1	0.00760	0.41	0.5247
S x E x G	0.07712	2	0.03856	2.09	0.1384
Error	0.64451	35	0.01841		
R x S x E	0.00370	2	0.00185	0.06	0.9454
R x S x E x G	0.26225	4	0.06556	1.99	0.1056
Error	2.30683	70	0.03295		

TABLE 23H

Summary Analysis of Variance for Number of Rounds Fired Per Moving Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	3.24183	2	1.62091	1.82	0.1768
Error	31.14647	35	0.88990		
Range (R)	3.74214	2	1.87107	7.60	0.0010
R x G	0.84573	4	0.21143	0.86	0.4931
Error	17.23431	70	0.24620		
Speed (S)	14.80014	1	14.80014	75.55	0.0000
S x G	0.05513	2	0.02756	0.14	0.8692
Error	6.85619	35	0.19589		
R x S	3.21590	2	1.60795	11.15	0.0001
R x S x G	0.55319	4	0.13830	0.96	0.4354
Error	10.09264	70	0.14418		
Exposure Time (E)	28.94897	1	28.94897	233.79	0.0000
E x G	0.32536	2	0.16268	1.31	0.2817
Error	4.33377	35	0.12382		
R x E	7.68062	2	3.84031	36.44	0.0000
R x E x G	0.61705	4	0.15426	1.46	0.2225
Error	7.37637	70	0.10538		
S x E	0.11832	1	0.11832	0.86	0.3604
S x E x G	0.06733	2	0.03366	0.24	0.7845
Error	4.82207	35	0.13777		
R x S x E	0.10987	2	0.05494	0.44	0.6439
R x S x E x G	0.71959	4	0.17990	1.45	0.2266
Error	8.68173	70	0.12402		

TABLE 24H

Summary Analysis of Variance for Proportion
of First Round Hits for Moving Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.00877	2	0.00438	0.02	0.9841
Error	9.53797	35	0.27251		
Range (R)	10.30025	2	5.15013	77.06	0.0000
R x G	0.24004	4	0.06001	0.90	0.4700
Error	4.67827	70	0.06683		
Speed (S)	2.45281	1	2.45281	30.22	0.0000
S x G	0.01590	2	0.00795	0.10	0.9070
Error	2.84115	35	0.08118		
R x S	0.96314	2	0.48157	12.46	0.0000
R x S x G	0.26360	4	0.06590	1.70	0.1587
Error	2.70625	70	0.03866		
Exposure Time (E)	0.05468	1	0.05468	1.58	0.2168
E x G	0.03793	2	0.01896	0.55	0.5825
Error	1.20947	35	0.03456		
R x E	0.07164	2	0.03582	0.92	0.4034
R x E x G	0.14255	4	0.03564	0.91	0.4602
Error	2.72642	70	0.03895		
S x E	0.08400	1	0.08400	1.96	0.1702
S x E x G	0.03649	2	0.01825	0.43	0.6565
Error	1.49928	35	0.04284		
R x S x E	0.01869	2	0.00935	0.24	0.7888
R x S x E x G	0.15833	4	0.03958	1.01	0.4092
Error	2.74792	70	0.03926		

APPENDIX I

SUMMARY MEANS AND STANDARD DEVIATIONS FOR PRODUCT MEASURES OF MARKSMANSHIP PERFORMANCE

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TABLE 1I

Means and Standard Deviations for Parametric Experiment: Proportion of Static Targets Engaged

Treatment	Range (m)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	0.98	0.09	0.99	0.04
		5.25	1.00	0.00	0.99	0.04
		7.25	0.99	0.04	0.94	0.15
	120	3.25	0.87	0.14	0.93	0.11
		5.25	0.99	0.04	0.96	0.10
		7.25	1.00	0.00	0.99	0.04
	180	3.25	0.84	0.20	0.90	0.13
		5.25	0.97	0.09	0.98	0.09
		7.25	0.99	0.04	0.99	0.04
	250	3.25	0.77	0.14	0.85	0.15
		5.25	0.97	0.09	0.96	0.10
		7.25	0.98	0.06	0.95	0.14
	300	3.25	0.68	0.22	0.76	0.23
		5.25	0.94	0.14	0.92	0.16
		7.25	0.97	0.09	0.98	0.06
Field	60	3.25	0.98	0.06	0.96	0.07
		5.25	0.99	0.04	0.99	0.04
		7.25	1.00	0.00	0.98	0.09
	120	3.25	0.91	0.10	0.90	0.17
		5.25	0.97	0.09	0.95	0.08
		7.25	0.92	0.12	0.96	0.07
	180	3.25	0.80	0.18	0.80	0.18
		5.25	0.99	0.04	0.98	0.06
		7.25	0.98	0.06	0.98	0.06
	250	3.25	0.80	0.21	0.87	0.13
		5.25	0.96	0.10	1.00	0.00
		7.25	0.93	0.11	0.90	0.14
	300	3.25	0.62	0.18	0.74	0.14
		5.25	0.89	0.15	0.96	0.10
		7.25	0.94	0.10	0.95	0.08

TABLE 2I

Means and Standard Deviations for Parametric Experiment: Proportion of Static Targets Hit

Treatment	Range (m)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	0.91	0.19	0.89	0.18
		5.25	1.00	0.00	0.98	0.09
		7.25	0.99	0.04	0.92	0.21
	120	3.25	0.67	0.29	0.58	0.28
		5.25	0.98	0.09	0.95	0.10
		7.25	1.00	0.00	0.95	0.10
	180	3.25	0.44	0.30	0.45	0.26
		5.25	0.81	0.21	0.76	0.25
		7.25	0.09	0.08	0.82	0.23
	250	3.25	0.16	0.15	0.26	0.16
		5.25	0.66	0.26	0.51	0.27
		7.25	0.82	0.12	0.73	0.27
	300	3.25	0.14	0.21	0.21	0.20
		5.25	0.42	0.20	0.37	0.21
		7.25	0.57	0.15	0.52	0.27
Field	60	3.25	0.98	0.06	0.95	0.08
		5.25	0.99	0.04	0.98	0.06
		7.25	1.00	0.00	0.96	0.10
	120	3.25	0.69	0.25	0.56	0.19
		5.25	0.92	0.12	0.82	0.18
		7.25	0.92	0.12	0.85	0.12
	180	3.25	0.41	0.20	0.30	0.25
		5.25	0.74	0.20	0.68	0.21
		7.25	0.88	0.13	0.92	0.09
	250	3.25	0.30	0.17	0.25	0.18
		5.25	0.59	0.26	0.54	0.22
		7.25	0.73	0.11	0.56	0.09
	300	3.25	0.08	0.11	0.08	0.09
		5.25	0.43	0.22	0.30	0.21
		7.25	0.62	0.21	0.43	0.18

TABLE 3I

Means and Standard Deviations for Parametric Experiment: Number of Rounds Fired Per Static Target

Treatment	Range (m)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	2.41	0.87	1.39	0.58
		5.25	2.53	0.89	1.43	0.46
		7.25	2.62	0.74	1.32	0.47
	120	3.25	1.56	0.70	1.21	0.34
		5.25	2.18	0.86	1.43	0.48
		7.25	2.17	0.74	1.46	0.39
	180	3.25	1.41	0.67	1.12	0.38
		5.25	2.01	0.89	1.89	0.48
		7.25	2.44	0.98	1.95	0.62
	250	3.25	0.99	0.24	1.01	0.32
		5.25	2.35	0.90	1.90	0.59
		7.25	2.87	1.14	2.55	0.81
	300	3.25	1.06	0.42	0.98	0.42
		5.25	2.32	0.84	2.01	0.76
		7.25	3.15	1.05	2.61	0.88
Field	60	3.25	1.04	0.21	0.96	0.12
		5.25	1.08	0.21	0.96	0.07
		7.25	1.05	0.11	1.00	0.11
	120	3.25	0.94	0.13	0.87	0.16
		5.25	0.99	0.13	1.12	0.23
		7.25	1.00	0.18	1.24	0.26
	180	3.25	0.87	0.18	0.90	0.30
		5.25	1.19	0.19	1.32	0.24
		7.25	1.32	0.26	1.25	0.20
	250	3.25	0.83	0.20	0.88	0.18
		5.25	1.32	0.17	1.48	0.22
		7.25	1.30	0.36	1.57	0.37
	300	3.25	0.63	0.17	0.74	0.24
		5.25	1.18	0.39	1.36	0.23
		7.25	1.53	0.53	1.63	0.32

TABLE 4I

Means and Standard Deviations for Parametric
Experiment: Proportion of First Round Hits for Static Targets

Treatment	Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	0.81	0.21	0.86	0.17
		5.25	0.90	0.19	0.92	0.16
		7.25	0.82	0.23	0.86	0.21
	120	3.25	0.56	0.28	0.55	0.26
		5.25	0.81	0.18	0.70	0.16
		7.25	0.79	0.19	0.80	0.19
	180	3.25	0.40	0.30	0.44	0.24
		5.25	0.56	0.24	0.39	0.25
		7.25	0.48	0.23	0.40	0.27
	250	3.25	0.14	0.14	0.24	0.17
		5.25	0.24	0.20	0.25	0.28
		7.25	0.29	0.22	0.21	0.23
	300	3.25	0.13	0.21	0.19	0.16
		5.25	0.14	0.14	0.19	0.14
		7.25	0.21	0.13	0.20	0.26
Field	60	3.25	0.96	0.08	0.92	0.13
		5.25	0.99	0.04	0.95	0.08
		7.25	0.99	0.04	0.93	0.14
	120	3.25	0.67	0.25	0.55	0.21
		5.25	0.92	0.12	0.73	0.20
		7.25	0.83	0.18	0.69	0.17
	180	3.25	0.40	0.20	0.25	0.21
		5.25	0.71	0.21	0.61	0.17
		7.25	0.67	0.25	0.74	0.16
	250	3.25	0.30	0.17	0.24	0.21
		5.25	0.50	0.21	0.39	0.12
		7.25	0.56	0.30	0.46	0.25
	300	3.25	0.08	0.11	0.07	0.09
		5.25	0.42	0.25	0.25	0.16
		7.25	0.44	0.24	0.31	0.17

TABLE 5I

Means and Standard Deviations for Parametric Experiment: Proportion of Moving Targets Engaged

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	0.97	0.09	0.98	0.07
			5.25	1.00	0.00	0.98	0.07
		12	3.25	1.00	0.00	1.00	0.00
			5.25	1.00	0.00	0.98	0.07
	120	6	3.25	0.95	0.10	0.98	0.07
			5.25	1.00	0.00	1.00	0.00
		12	3.25	0.97	0.09	1.00	0.00
			5.25	1.00	0.00	1.00	0.00
	180	6	3.25	0.90	0.18	0.91	0.16
			5.25	1.00	0.00	1.00	0.00
		12	3.25	0.93	0.15	0.98	0.07
			5.25	0.97	0.09	1.00	0.00
Field	60	6	3.25	1.00	0.00	1.00	0.00
			5.25	1.00	0.00	0.98	0.07
		12	3.25	0.98	0.06	0.98	0.07
			5.25	0.97	0.09	0.98	0.07
	120	6	3.25	0.92	0.15	0.89	0.16
			5.25	1.00	0.00	0.96	0.13
		12	3.25	0.97	0.09	0.93	0.15
			5.25	0.98	0.06	0.95	0.11
	180	6	3.25	0.98	0.06	0.96	0.09
			5.25	1.00	0.00	1.00	0.00
		12	3.25	0.98	0.06	0.95	0.11
			5.25	1.00	0.00	1.00	0.00

TABLE 6I

Means and Standard Deviations for Parametric Experiment: Proportion of Moving Targets Hit

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	0.80	0.27	0.89	0.19
			5.25	1.00	0.00	0.96	0.13
		12	3.25	0.77	0.27	0.66	0.33
			5.25	0.92	0.15	0.91	0.19
	120	6	3.25	0.47	0.27	0.43	0.30
			5.25	0.90	0.13	0.89	0.13
		12	3.25	0.37	0.23	0.43	0.27
			5.25	0.68	0.26	0.77	0.29
	180	6	3.25	0.48	0.27	0.39	0.23
			5.25	0.70	0.25	0.70	0.24
		12	3.25	0.17	0.28	0.25	0.29
			5.25	0.53	0.33	0.41	0.30
Field	60	6	3.25	0.93	0.15	0.86	0.21
			5.25	0.95	0.14	0.88	0.21
		12	3.25	0.83	0.20	0.70	0.20
			5.25	0.78	0.19	0.80	0.20
	120	6	3.25	0.45	0.30	0.45	0.24
			5.25	0.70	0.36	0.57	0.25
		12	3.25	0.30	0.32	0.43	0.27
			5.25	0.65	0.28	0.48	0.25
	180	6	3.25	0.33	0.36	0.45	0.22
			5.25	0.42	0.22	0.50	0.29
		12	3.25	0.18	0.20	0.16	0.21
			5.25	0.40	0.21	0.38	0.27

TABLE 7I

Means and Standard Deviations for Parametric Experiment: Number of Rounds Fired Per Moving Target

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	1.92	0.54	1.52	0.44
			5.25	2.62	0.96	1.52	0.49
		12	3.25	2.50	1.08	1.73	0.52
			5.25	3.03	0.97	2.20	0.82
	120	6	3.25	1.50	0.54	1.30	0.41
			5.25	2.15	0.75	1.82	0.45
		12	3.25	1.71	0.71	1.61	0.41
			5.25	2.98	1.03	2.55	0.61
	180	6	3.25	1.33	0.44	1.20	0.41
			5.25	2.73	0.73	2.32	0.67
		12	3.25	1.54	0.58	1.45	0.43
			5.25	3.38	1.20	2.68	0.62
Field	60	6	3.25	1.31	0.29	1.13	0.21
			5.25	1.31	0.31	1.30	0.30
		12	3.25	1.85	0.48	1.70	0.37
			5.25	2.08	0.61	1.80	0.45
	120	6	3.25	1.00	0.25	1.00	0.20
			5.25	1.58	0.44	1.57	0.39
		12	3.25	1.23	0.19	1.25	0.35
			5.25	1.71	0.30	2.00	0.66
	180	6	3.25	1.23	0.30	1.09	0.35
			5.25	2.02	0.45	1.91	0.55
		12	3.25	1.31	0.34	1.29	0.31
			5.25	2.31	0.55	2.34	0.57

TABLE 8I

Means and Standard Deviations for Parametric
Experiment: Proportion of First Round Hits for Moving Targets

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	0.61	0.30	0.79	0.27
			5.25	0.70	0.17	0.77	0.29
		12	3.25	0.42	0.32	0.48	0.27
			5.25	0.37	0.28	0.48	0.29
	120	6	3.25	0.40	0.25	0.38	0.31
			5.25	0.57	0.24	0.55	0.20
		12	3.25	0.17	0.18	0.32	0.25
			5.25	0.22	0.21	0.23	0.23
	180	6	3.25	0.40	0.25	0.32	0.18
			5.25	0.33	0.31	0.32	0.28
		12	3.25	0.10	0.16	0.18	0.27
			5.25	0.12	0.16	0.16	0.16
Field	60	6	3.25	0.87	0.19	0.82	0.21
			5.25	0.83	0.20	0.73	0.27
		12	3.25	0.55	0.29	0.52	0.25
			5.25	0.47	0.23	0.59	0.32
	120	6	3.25	0.43	0.29	0.43	0.23
			5.25	0.48	0.36	0.43	0.25
		12	3.25	0.28	0.31	0.43	0.27
			5.25	0.47	0.23	0.41	0.27
	180	6	3.25	0.32	0.35	0.43	0.23
			5.25	0.28	0.19	0.38	0.27
		12	3.25	0.17	0.20	0.16	0.21
			5.25	0.28	0.21	0.23	0.21

TABLE 9I

Means and Standard Deviations for Training Experiment (Field): Proportion of Static Targets Engaged

Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	3.25	0.98	0.06	0.96	0.07	0.98	0.06
	5.25	0.99	0.04	0.99	0.04	0.91	0.12
	7.25	1.00	0.00	0.98	0.09	0.94	0.12
120	3.25	0.91	0.11	0.90	0.17	0.89	0.12
	5.25	0.97	0.09	0.95	0.08	0.94	0.12
	7.25	0.92	0.12	0.96	0.07	1.00	0.00
180	3.25	0.80	0.18	0.80	0.18	0.93	0.12
	5.25	0.99	0.04	0.98	0.06	0.96	0.07
	7.25	0.98	0.06	0.98	0.06	0.94	0.08
250	3.25	0.80	0.21	0.87	0.13	0.93	0.09
	5.25	0.96	0.10	1.00	0.00	0.96	0.07
	7.25	0.93	0.11	0.90	0.14	0.96	0.11
300	3.25	0.62	0.18	0.74	0.14	0.80	0.14
	5.25	0.89	0.15	0.96	0.10	1.00	0.00
	7.25	0.94	0.10	0.95	0.08	0.96	0.07

TABLE 10I

Means and Standard Deviations for Training
Experiment (Field): Proportion of Static Targets Hit

Range (m)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	3.25	0.98	0.06	0.95	0.08	0.94	0.08
	5.25	0.99	0.04	0.98	0.06	0.91	0.12
	7.25	1.00	0.00	0.96	0.10	0.94	0.12
120	3.25	0.69	0.25	0.56	0.19	0.63	0.16
	5.25	0.92	0.12	0.82	0.18	0.81	0.13
	7.25	0.92	0.12	0.85	0.12	0.96	0.07
180	3.25	0.41	0.20	0.30	0.25	0.48	0.35
	5.25	0.74	0.20	0.68	0.21	0.69	0.28
	7.25	0.88	0.13	0.92	0.09	0.81	0.13
250	3.25	0.30	0.17	0.25	0.24	0.28	0.17
	5.25	0.59	0.19	0.54	0.18	0.54	0.34
	7.25	0.73	0.26	0.56	0.22	0.48	0.27
300	3.25	0.08	0.11	0.07	0.09	0.06	0.12
	5.25	0.43	0.22	0.30	0.21	0.33	0.31
	7.25	0.62	0.21	0.43	0.18	0.48	0.26

TABLE 11I

Means and Standard Deviations for Training Experiment (Field): Number of Rounds Fired per Static Target

Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	3.25	1.04	0.19	0.96	0.12	1.11	0.24
	5.25	1.08	0.20	0.96	0.07	1.07	0.29
	7.25	1.06	0.10	1.00	0.11	1.11	0.20
120	3.25	0.94	0.12	0.87	0.16	1.13	0.26
	5.25	0.99	0.12	1.12	0.23	1.52	0.44
	7.25	1.01	0.17	1.24	0.26	1.70	0.47
180	3.25	0.83	0.22	0.90	0.30	1.19	0.10
	5.25	1.18	0.18	1.32	0.24	1.81	0.54
	7.25	1.32	0.24	1.25	0.20	2.09	0.80
250	3.25	0.82	0.21	0.88	0.18	1.22	0.31
	5.25	1.30	0.18	1.48	0.22	1.96	0.47
	7.25	1.29	0.34	1.57	0.37	2.43	0.60
300	3.25	0.61	0.17	0.74	0.24	0.98	0.23
	5.25	1.17	0.36	1.36	0.23	2.22	0.53
	7.25	1.50	0.50	1.63	0.32	2.85	0.65

TABLE 12I

Means and Standard Deviations for Training
Experiment (Field): Proportion of First Round Hits for Static Targets

Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	3.25	0.96	0.08	0.92	0.13	0.93	0.09
	5.25	0.99	0.04	0.95	0.08	0.91	0.12
	7.25	0.99	0.04	0.93	0.14	0.85	0.18
120	3.25	0.67	0.25	0.55	0.21	0.59	0.22
	5.25	0.92	0.12	0.73	0.20	0.56	0.19
	7.25	0.83	0.18	0.69	0.17	0.59	0.24
180	3.25	0.40	0.20	0.25	0.21	0.46	0.36
	5.25	0.71	0.21	0.61	0.17	0.41	0.26
	7.25	0.67	0.25	0.74	0.16	0.41	0.29
250	3.25	0.30	0.17	0.24	0.21	0.24	0.17
	5.25	0.50	0.21	0.39	0.12	0.26	0.22
	7.25	0.56	0.30	0.46	0.25	0.24	0.26
300	3.25	0.08	0.11	0.07	0.09	0.06	0.12
	5.25	0.42	0.25	0.25	0.16	0.19	0.15
	7.25	0.44	0.24	0.31	0.17	0.11	0.12

TABLE 13I

Means and Standard Deviations for Training
Experiment(Field): Proportion of Moving Targets Engaged

Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	6	3.25	1.00	0.00	1.00	0.00	0.94	0.11
		5.25	1.00	0.00	0.98	0.07	1.00	0.00
	12	3.25	0.98	0.06	0.98	0.07	0.89	0.18
		5.25	0.97	0.09	0.98	0.07	0.97	0.08
120	6	3.25	0.92	0.15	0.89	0.16	1.00	0.00
		5.25	1.00	0.00	0.96	0.13	0.97	0.08
	12	3.25	0.97	0.09	0.93	0.15	0.94	0.11
		5.25	0.98	0.06	0.95	0.11	0.97	0.08
180	6	3.25	0.98	0.06	0.96	0.09	0.97	0.08
		5.25	1.00	0.00	1.00	0.00	1.00	0.00
	12	3.25	0.98	0.64	0.95	0.11	1.00	0.00
		5.25	1.00	0.00	1.00	0.00	0.86	0.18

TABLE 14I

Means and Standard Deviations for Training Experiment (Field): Proportion of Moving Targets Hit

Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	6	3.25	0.93	0.15	0.86	0.21	0.81	0.24
		5.25	0.95	0.14	0.88	0.21	0.92	0.18
	12	3.25	0.83	0.20	0.70	0.20	0.64	0.25
		5.25	0.78	0.19	0.80	0.20	0.81	0.21
120	6	3.25	0.45	0.30	0.45	0.24	0.50	0.35
		5.25	0.70	0.36	0.57	0.25	0.67	0.31
	12	3.25	0.30	0.32	0.43	0.27	0.53	0.26
		5.25	0.65	0.28	0.48	0.25	0.67	0.25
180	6	3.25	0.33	0.36	0.45	0.22	0.31	0.27
		5.25	0.42	0.22	0.50	0.29	0.56	0.39
	12	3.25	0.18	0.20	0.16	0.21	0.33	0.18
		5.25	0.40	0.21	0.38	0.27	0.36	0.28

TABLE 15I

Means and Standard Deviations for Training Experiment (Field): Number of Rounds Fired per Moving Targets

Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	6	3.25	1.28	0.28	1.13	0.21	1.33	0.43
		5.25	1.30	0.29	1.30	0.30	1.44	0.35
	12	3.25	1.90	0.48	1.70	0.37	1.75	0.79
		5.25	2.15	0.61	1.80	0.45	2.17	0.89
120	6	3.25	1.02	0.24	1.00	0.20	1.39	0.33
		5.25	1.63	0.43	1.57	0.39	1.78	0.86
	12	3.25	1.28	0.23	1.25	0.35	1.61	0.47
		5.25	1.83	0.45	2.00	0.66	1.97	0.40
180	6	3.25	1.22	0.28	1.09	0.35	1.36	0.42
		5.25	2.03	0.42	1.91	0.55	2.19	0.67
	12	3.25	1.32	0.35	1.29	0.31	1.75	0.67
		5.25	2.25	0.53	2.34	0.57	2.28	0.74

TABLE 16I

Means and Standard Deviations for Training
Experiment (Field): Proportion of First Round Hits for Moving Targets

Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	6	3.25	0.87	0.19	0.82	0.21	0.75	0.28
		5.25	0.83	0.20	0.73	0.27	0.75	0.28
	12	3.25	0.55	0.29	0.52	0.25	0.44	0.21
		5.25	0.47	0.23	0.59	0.32	0.53	0.26
120	6	3.25	0.43	0.29	0.43	0.23	0.47	0.32
		5.25	0.48	0.36	0.43	0.25	0.56	0.30
	12	3.25	0.28	0.31	0.43	0.27	0.44	0.27
		5.25	0.47	0.23	0.41	0.27	0.47	0.20
180	6	3.25	0.32	0.35	0.43	0.23	0.31	0.27
		5.25	0.2[illegible]	0.19	0.38	0.27	0.33	0.33
	12	3.25	0.17	0.20	0.16	0.21	0.22	0.20
		5.25	0.28	0.21	0.23	0.21	0.22	0.23

APPENDIX J

SUMMARY ANALYSIS OF VARIANCE TABLES FOR RATE OF FIRING MEASURES OF MARKSMANSHIP PERFORMANCE

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TABLE 1J

Summary Analysis of Variance for Average Time
to Fire First Round for Static Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	1.24276	1	1.24276	0.95	0.3393
Error	35.45552	27	1.31317		
Treatment (T)	11.72642	1	11.72642	19.66	0.0001
T x G	0.38932	1	0.38932	0.65	0.4262
Error	16.10330	27	0.59642		
Range (R)	147.71230	4	36.92807	390.08	0.0000
R x G	1.77275	4	0.44319	4.68	0.0016
Error	10.22414	108	0.09467		
T x R	3.48902	4	0.87226	7.69	0.0000
T x R x G	0.31647	4	0.07912	0.70	0.5951
Error	12.24585	108	0.11339		
Exposure Time (E)	6.84056	2	3.42028	45.73	0.0000
E x G	0.51996	2	0.25998	3.48	0.0380
Error	4.03873	54	0.07479		
T x E	0.73213	2	0.36606	5.06	0.0097
T x E x G	0.14220	2	0.07110	0.98	0.3812
Error	3.91001	54	0.07241		
R x E	6.22810	8	0.77851	13.72	0.0000
R x E x G	0.33191	8	0.04149	0.73	0.6640
Error	12.25802	216	0.05675		
T x R x E	0.53062	8	0.06633	1.39	0.2033
T x R x E x G	0.59297	8	0.07412	1.55	0.1415
Error	10.32782	216	0.04781		

TABLE 2J

Summary Analysis of Variance for Average Time
to First Hit for Static Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.36208	1	0.36208	0.16	0.6953
Error	62.37086	27	2.31003		
Treatment (T)	11.66082	1	11.66082	10.19	0.0036
T x G	0.36887	1	0.36887	0.32	0.5749
Error	30.89746	27	1.14435		
Range (R)	319.57413	4	79.89353	308.68	0.0000
R x G	1.68843	4	0.42211	1.63	0.1717
Error	27.95288	108	0.25882		
T x R	6.84057	4	1.71014	6.84	0.0001
T x R x G	0.90126	4	0.22532	0.90	0.4662
Error	27.01150	108	0.25011		
Exposure Time (E)	114.02363	2	57.01181	198.93	0.0000
E x G	0.37645	2	0.18823	0.66	0.5226
Error	15.47626	54	0.28660		
T x E	0.28104	2	0.14052	0.40	0.6730
T x E x G	0.40969	2	0.20484	0.58	0.5625
Error	19.02178	54	0.35226		
R x E	57.55749	8	7.19469	37.42	0.0000
R x E x G	1.24788	8	0.15598	0.81	0.5933
Error	41.53171	216	0.19228		
T x R x E	2.10212	8	0.26276	1.25	0.2699
T x R x E x G	2.35370	8	0.29421	1.40	0.1967
Error	45.30850	216	0.20976		

TABLE 3J

Summary Analysis of Variance for Average Number of Rounds to First Hit for Static Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.58500	1	0.58500	2.11	0.1586
Error	6.92495	25	0.27700		
Treatment (T)	11.92099	1	11.92099	64.41	0.0000
T x G	0.09931	1	0.09931	0.54	0.4707
Error	4.62723	25	0.18509		
Range (R)	6.34896	4	1.58724	23.46	0.0000
R x G	0.44293	4	0.11073	1.64	0.1709
Error	6.76558	100	0.06766		
T x R	3.34308	4	0.83577	11.16	0.0000
T x R x G	0.34925	4	0.08731	1.17	0.3303
Error	7.48627	100	0.07486		
Exposure Time (E)	40.54499	2	20.27250	238.79	0.0000
E x G	0.18505	2	0.09252	1.09	0.3441
Error	4.24492	50	0.08490		
T x E	4.61799	2	2.30899	19.67	0.0000
T x E x G	0.14666	2	0.07333	0.62	0.5396
Error	5.87042	50	0.11741		
R x E	12.72328	8	1.59041	26.15	0.0000
R x E x G	0.82397	8	0.10300	1.69	0.1018
Error	12.16238	200	0.06081		
T x R x E	3.61797	8	0.45225	6.40	0.0000
T x R x E x G	1.40069	8	0.17509	2.48	0.0139
Error	14.13436	200	0.07067		

TABLE 4J

Summary Analysis of Variance for Average Time
to Fire First Round for Moving Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.01907	1	0.01907	0.02	0.8948
Error	28.91719	27	1.07101		
Treatment (T)	0.42693	1	0.42693	0.63	0.4357
T x G	0.00279	1	0.00279	0.00	0.9495
Error	18.40882	27	0.68181		
Range (R)	43.48016	2	21.74008	202.14	0.0000
R x G	0.16205	2	0.08103	0.75	0.4756
Error	5.80763	54	0.10755		
T x R	2.13536	2	1.06768	8.21	0.0008
T x R x G	0.40381	2	0.20190	1.55	0.2208
Error	7.01898	54	0.12998		
Speed (S)	4.00400	1	4.00400	32.75	0.0000
S x G	0.21435	1	0.21435	1.75	0.1965
Error	3.30060	27	0.12224		
T x S	0.25432	1	0.25432	2.87	0.1015
T x S x G	0.09984	1	0.09984	1.13	0.2976
Error	2.38941	27	0.08850		
R x S	0.10219	2	0.05109	0.87	0.4243
R x S x G	0.04443	2	0.02221	0.38	0.6865
Error	3.16744	54	0.05866		
T x R x S	0.20837	2	0.10419	1.82	0.1710
T x R x S x G	0.09234	2	0.04617	0.81	0.4508
Error	3.08298	54	0.05709		
Exposure Time (E)	0.03747	1	0.03747	0.30	0.5894
E x G	0.11563	1	0.11563	0.92	0.3457
Error	3.38960	27	0.12554		
T x E	0.29317	1	0.29317	3.07	0.0909
T x E x G	0.10351	1	0.10351	1.09	0.3067
Error	2.57488	27	0.09537		
R x E	0.06672	2	0.03336	0.50	0.6073
R x E x G	0.01701	2	0.00850	0.13	0.8799
Error	3.57888	54	0.06628		
T x R x E	0.34529	2	0.17264	3.24	0.0470
T x R x E x G	0.06649	2	0.03325	0.62	0.5400
Error	2.88020	54	0.05334		
S x E	0.14069	1	0.14069	2.81	0.1051
SE x G	0.01173	1	0.01173	0.23	0.6322
Error	1.35126	27	0.05005		
T x S x E	0.16821	1	0.16821	3.71	0.0646
T x S x E x G	0.00086	1	0.00086	0.02	0.8915
Error	1.22322	27	0.04530		
R x S x E	0.02297	2	0.01148	0.32	0.7303
R x S x E x G	0.15107	2	0.07554	2.08	0.1350
Error	1.96206	54	0.03633		
T x R x S x E	0.11274	2	0.05637	1.38	0.2597
T x R x S x E x G	0.10165	2	0.05082	1.25	0.2956
Error	2.20160	54	0.04077		

TABLE 5J

Summary Analysis of Variance for Average Time
to First Hit for Moving Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.59339	1	0.59339	1.17	0.2896
Error	13.73106	27	0.50856		
Treatment (T)	2.50179	1	2.50179	7.96	0.0089
T x G	0.07357	1	0.07357	0.23	0.6325
Error	8.49111	27	0.31449		
Range (R)	64.84783	2	32.42392	241.29	0.0000
R x G	0.84777	2	0.42389	3.15	0.0506
Error	7.25648	54	0.13438		
T x R	1.09960	2	0.54980	4.82	0.0118
T x R x G	0.57196	2	0.28598	2.51	0.0908
Error	6.15586	54	0.11400		
Speed (S)	0.06801	1	0.06801	0.54	0.4690
S x G	1.01255	1	1.01255	8.03	0.0086
Error	3.40420	27	0.12608		
T x S	0.05804	1	0.05804	0.78	0.3856
T x S x G	0.03062	1	0.03062	0.41	0.5272
Error	2.01498	27	0.07463		
R x S	0.59653	2	0.29827	2.43	0.0978
R x S x G	0.04751	2	0.02375	0.19	0.8248
Error	6.63479	54	0.12287		
T x R x S	1.51508	2	0.75754	5.62	0.0061
T x R x S x G	0.66767	2	0.33383	2.48	0.0936
Error	7.28130	54	0.13484		
Exposure Time (E)	31.84143	1	31.84143	239.66	0.0000
E x G	0.85884	1	0.85884	6.46	0.0171
Error	3.58722	27	0.13286		
T x E	0.02325	1	0.02325	0.17	0.6862
T x E x G	0.06136	1	0.06136	0.44	0.5128
Error	3.76540	27	0.13946		
R x E	5.04001	2	2.52001	22.73	0.0000
R x E x G	0.49536	2	0.24768	2.23	0.1169
Error	5.98763	54	0.11088		
T x R x E	0.13650	2	0.06825	0.63	0.5347
T x R x E x G	0.16219	2	0.08109	0.75	0.4760
Error	5.81908	54	0.10776		
S x E	0.01623	1	0.01623	0.21	0.6496
S x E x G	0.49031	1	0.49031	6.38	0.0177
Error	2.07587	27	0.07688		
T x S x E	0.19610	1	0.19610	2.01	0.1673
T x S x E x G	0.00972	1	0.00972	0.10	0.7544
Error	2.62944	27	0.09739		
R x S x E	0.02348	2	0.01174	0.10	0.9088
R x S x E x G	0.53906	2	0.26953	2.20	0.1206
Error	6.61519	54	0.12250		
T x R x S x E	0.12300	2	0.06150	0.51	0.6011
T x R x S x E x G	0.17145	2	0.08572	0.72	0.4932
Error	6.46396	54	0.11970		

TABLE 6J

Summary Analysis of Variance for Average Number of Rounds to First Hit for Moving Targets for Parametric Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	3.18621	1	3.18621	12.59	0.0016
Error	6.32498	25	0.25300		
Treatment (T)	18.31019	1	18.31019	51.83	0.0000
T x G	0.28241	1	0.28241	0.80	0.3798
Error	8.83179	25	0.35327		
Range (R)	6.24314	2	3.12157	35.76	0.0000
R x G	0.97964	2	0.48982	5.61	0.0063
Error	4.36450	50	0.08729		
T x R	1.89134	2	0.94567	9.51	0.0003
T x R x G	0.58232	2	0.29116	2.93	0.0627
Error	4.97015	50	0.09940		
Speed (S)	2.53241	1	2.53241	13.07	0.0013
S x G	1.20834	1	1.20834	6.24	0.0194
Error	4.84220	25	0.19369		
T x S	1.53877	1	1.53877	9.69	0.0046
T x S x G	0.01099	1	0.01099	0.07	0.7946
Error	3.96818	25	0.15873		
R x S	0.09077	2	0.04538	0.37	0.6930
R x S x G	0.16831	2	0.08416	0.69	0.5087
Error	6.14226	50	0.12285		
T x R x S	0.11179	2	0.05589	0.54	0.5847
T x R x S x G	0.34906	2	0.17453	1.69	0.1942
Error	5.15210	50	0.10304		
Exposure Time (E)	25.09938	1	25.09938	146.17	0.0000
E x G	0.01604	1	0.01604	0.09	0.7624
Error	4.29298	25	0.17172		
T x E	3.24889	1	3.24889	18.94	0.0002
T x E x G	0.19333	1	0.19333	1.13	0.2986
Error	4.28892	25	0.17156		
R x E	1.35028	2	0.67514	5.81	0.0054
R x E x G	0.45792	2	0.22896	1.97	0.1503
Error	5.81407	50	0.11628		
T x R x E	0.13981	2	0.06991	0.72	0.4913
T x R x E x G	1.32384	2	0.66192	6.83	0.0024
Error	4.84784	50	0.09696		
S x E	0.16383	1	0.16383	1.01	0.3236
S x E x G	0.04037	1	0.04037	0.25	0.6216
Error	4.03949	25	0.16158		
T x S x E	0.14001	1	0.14001	1.23	0.2782
T x S x E x G	0.00112	1	0.00112	0.01	0.9218
Error	2.84919	25	0.11397		
R x S x E	0.03592	2	0.01796	0.14	0.8672
R x S x E x G	1.48461	2	0.74230	5.91	0.0050
Error	6.28391	50	0.12568		
T x R x S x E	0.04749	2	0.02375	0.16	0.8527
T x R x S x E x G	1.00930	2	0.50465	3.40	0.0414

TABLE 7J

Summary Analysis of Variance for Average Time
to Fire First Round for Static Targets for Training Study

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	19.91164	2	9.95582	12.49	0.0001
Error	27.90291	35	0.79723		
Range (R)	80.82895	4	20.20724	243.88	0.0000
R x G	3.24796	8	0.40600	4.90	0.0000
Error	11.60021	140	0.08286		
Exposure Time (E)	4.60683	2	2.30342	40.59	0.0000
E x G	0.67357	4	0.16839	2.97	0.0253
Error	3.97278	70	0.05675		
R x E	2.26581	8	0.28323	5.68	0.0000
R x E x G	1.28673	16	0.08042	1.61	0.0651
Error	13.97026	280	0.04989		

TABLE 8J

Summary Analysis of Variance for Average Time
to First Hit for Static Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	0.73190	2	0.36595	0.46	0.6374
Error	28.07758	35	0.80222		
Range (R)	197.74456	4	49.43614	210.62	0.0000
R x G	2.57650	8	0.32206	1.37	0.2138
Error	32.86087	140	0.23472		
Exposure Time (E)	89.35614	2	44.67807	195.89	0.0000
E x G	4.58976	4	1.14744	5.03	0.0013
Error	15.96530	70	0.22808		
R x E	31.12853	8	3.89107	22.31	0.0000
R x E x G	3.63330	16	0.22708	1.30	0.1947
Error	48.82639	280	0.17438		

TABLE 9J

Summary Analysis of Variance for Average Number of Rounds to First Hit for Static Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	3.86641	2	1.93320	21.85	0.0000
Error	3.09621	35	0.08846		
Range (R)	5.85230	4	1.46308	28.89	0.0000
R x G	2.12054	8	0.28507	5.23	0.0000
Error	7.09009	140	0.05064		
Exposure Time (E)	20.35767	2	10.17883	218.66	0.0000
E x G	2.10061	4	0.52516	11.28	0.0000
Error	3.25855	70	0.04655		
R x E	4.92105	8	0.01513	13.92	0.0000
R x E x G	2.10006	16	0.13125	2.97	0.0001
Error	12.37411	280	0.04419		

TABLE 10J

Summary Analysis of Variance for Average Time
to Fire First Round for Moving Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	4.20467	2	2.10234	3.94	0.0286
Error	18.67746	35	0.53364		
Range (R)	26.58437	2	13.29218	151.68	0.0000
R x G	1.47490	4	0.36873	4.21	0.0041
Error	6.13422	70	0.08763		
Speed (S)	2.41002	1	2.41002	28.31	0.0000
S x G	0.54764	2	0.27382	3.22	0.0522
Error	2.97975	35	0.08514		
R x S	0.36147	2	0.18073	2.83	0.0659
R x S x G	0.95218	4	0.23804	3.73	0.0083
Error	4.47326	70	0.06390		
Exposure Time (E)	0.01735	1	0.01735	0.25	0.6207
E x G	0.28309	2	0.14154	2.03	0.1460
Error	2.43588	35	0.06960		
R x E	0.03910	2	0.01955	0.44	0.6451
R x E x G	0.16847	4	0.04212	0.95	0.4402
Error	3.10170	70	0.04431		
S x E	0.30058	1	0.30058	6.83	0.0131
S x E x G	0.01210	2	0.00605	0.14	0.8720
Error	1.54108	35	0.04403		
R x S x E	0.00772	2	0.00386	0.10	0.9062
R x S x E x G	0.26295	4	0.06574	1.68	0.1645
Error	2.74038	70	0.03915		

TABLE 11J

Summary Analysis of Variance for Average Time
to First Hit for Moving Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	2.47105	2	1.23553	3.13	0.0560
Error	13.80441	35	0.39441		
Range (R)	38.58738	2	19.29369	128.97	0.0000
R x G	1.71396	4	0.42849	2.86	0.0294
Error	10.47183	70	0.14960		
Speed (S)	0.11206	1	0.11206	0.94	0.3398
S x G	0.35363	2	0.17681	1.48	0.2421
Error	4.18832	35	0.11967		
R x S	2.28641	2	1.14320	6.97	0.0017
R x S x G	0.55088	4	0.13772	0.84	0.5044
Error	11.47579	70	0.16394		
Exposure Time (E)	14.80190	1	14.80190	135.24	0.0000
E x G	1.11464	2	0.55732	5.09	0.0115
Error	3.83064	35	0.10945		
R x E	3.52792	2	1.76396	17.90	0.0000
R x E x G	0.72730	4	0.18182	1.85	0.1299
Error	6.89762	70	0.09854		
S x E	0.01171	1	0.01171	0.12	0.7361
S x E x G	0.34962	2	0.17481	1.72	0.1933
Error	3.55111	35	0.10146		
R x S x E	0.01070	2	0.00535	0.04	0.9638
R x S x E x G	0.25773	4	0.06443	0.44	0.7764
Error	10.16017	70	0.14515		

TABLE 12J

Summary Analysis of Variance for Average Number of Rounds to First Hit for Moving Targets for Training Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob
Group (G)	1.19285	2	0.59642	5.28	0.0099
Error	3.95203	35	0.11292		
Range (R)	6.78568	2	3.39284	49.35	0.0000
R x G	0.95045	4	0.23761	3.46	0.0123
Error	4.81298	70	0.06876		
Speed (S)	0.18355	1	0.18355	2.44	0.1275
S x G	0.50085	2	0.25042	3.32	0.0477
Error	2.63635	35	0.07481		
R x S	0.17557	2	0.08778	1.17	0.3153
R x S x G	0.14287	4	0.03572	0.48	0.7522
Error	5.23679	70	0.07481		
Exposure Time (E)	8.67732	1	8.67732	144.76	0.0000
E x G	0.25302	2	0.12651	2.11	0.1363
Error	2.09799	35	0.05994		
R x E	0.26159	2	0.13079	1.77	0.1780
R x E x G	0.71817	4	0.17954	2.43	0.0557
Error	5.17465	70	0.07392		
S x E	0.00058	1	0.00058	0.01	0.9100
S x E x G	0.03198	2	0.01599	0.36	0.7022
Error	1.56684	35	0.04477		
R x S x E	0.19427	2	0.09713	1.28	0.2837
R x S x E x G	0.26233	4	0.06558	0.87	0.4887
Error	5.30045	70	0.07572		

APPENDIX K

SUMMARY MEANS AND STANDARD DEVIATIONS FOR RATE OF FIRING MEASURES OF MARKSMANSHIP PERFORMANCE

TABLE OF CONTENTS

TABLE 1K

Means and Standard Deviations for Parametric
Experiment: Average Time to Fire First Round for Static Targets

Treatment	Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	2.12	0.30	2.24	0.46
		5.25	2.07	0.27	2.20	0.30
		7.25	2.07	0.34	2.24	0.25
	120	3.25	2.50	0.34	2.60	0.26
		5.25	2.57	0.30	2.50	0.22
		7.25	2.70	0.34	2.60	0.24
	180	3.25	2.78	0.31	2.91	0.38
		5.25	2.97	0.55	2.84	0.30
		7.25	2.97	0.43	2.96	0.31
	250	3.25	3.17	0.31	3.14	0.26
		5.25	3.31	0.37	3.27	0.41
		7.25	3.32	0.39	3.04	0.40
	300	3.25	2.87	0.27	2.91	0.28
		5.25	3.49	0.58	3.20	0.44
		7.25	3.49	0.52	3.25	0.63
Field	60	3.25	2.23	0.25	2.27	0.25
		5.25	2.30	0.23	2.36	0.35
		7.25	2.34	0.30	2.39	0.34
	120	3.25	2.84	0.21	2.75	0.23
		5.25	2.92	0.31	2.67	0.29
		7.25	2.99	0.42	2.98	0.41
	180	3.25	3.13	0.13	2.97	0.30
		5.25	3.40	0.40	3.22	0.41
		7.25	3.43	0.40	3.12	0.39
	250	3.25	3.16	0.28	3.06	0.29
		5.25	3.40	0.35	3.15	0.34
		7.25	3.39	0.32	3.25	0.38
	300	3.25	3.29	0.27	3.18	0.32
		5.25	3.70	0.38	3.59	0.39
		7.25	4.01	0.44	3.80	0.58

TABLE 2K

Means and Standard Deviations for Parametric
Experiment: Average Time to First Hit for Static Targets

Treatment	Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	2.10	0.29	2.15	0.26
		5.25	2.09	0.27	2.10	0.51
		7.25	2.09	0.35	2.16	0.39
	120	3.25	2.25	0.31	2.44	0.23
		5.25	2.68	0.32	2.64	0.59
		7.25	2.81	0.31	2.68	0.54
	180	3.25	2.82	0.33	2.66	0.52
		5.25	3.21	0.49	3.39	0.58
		7.25	3.39	0.64	3.56	0.92
	250	3.25	2.91	0.42	3.05	0.29
		5.25	3.94	0.54	3.87	1.17
		7.25	4.31	1.01	4.60	1.40
	300	3.25	2.71	0.21	2.72	0.32
		5.25	4.10	0.85	3.61	0.91
		7.25	4.75	1.06	4.56	1.31
Field	60	3.25	2.26	0.25	2.32	0.28
		5.25	2.31	0.23	2.37	0.34
		7.25	2.38	0.27	2.48	0.47
	120	3.25	2.86	0.24	2.77	0.29
		5.25	2.98	0.29	2.90	0.41
		7.25	3.27	0.56	3.39	0.55
	180	3.25	3.04	0.30	3.09	0.29
		5.25	3.61	0.45	3.49	0.41
		7.25	4.07	0.72	3.60	0.49
	250	3.25	3.10	0.20	3.03	0.22
		5.25	3.93	0.41	3.77	0.43
		7.25	4.20	0.75	4.09	0.85
	300	3.25	3.07	0.23	3.08	0.21
		5.25	4.16	0.60	4.08	0.68
		7.25	5.03	0.71	4.59	0.80

TABLE 3K

Means and Standard Deviations for Parametric
Experiment: Average Number of Rounds to First Hit for Static Targets

Treatment	Range (m)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	3.25	0.96	0.24	0.93	0.21
		5.25	1.08	0.15	1.04	0.12
		7.25	1.15	0.32	0.98	0.25
	120	3.25	0.82	0.27	0.79	0.15
		5.25	1.14	0.23	1.21	0.20
		7.25	1.26	0.25	1.15	0.18
	180	3.25	0.64	0.23	0.61	0.18
		5.25	1.18	0.44	1.21	0.42
		7.25	1.53	0.41	1.40	0.40
	250	3.25	0.44	0.08	0.39	0.11
		5.25	1.33	0.59	1.04	0.39
		7.25	1.76	0.46	1.88	0.87
	300	3.25	0.53	0.06	0.49	0.14
		5.25	1.01	0.47	0.74	0.30
		7.25	1.46	0.64	1.29	0.47
Field	60	3.25	1.00	0.10	0.93	0.11
		5.25	0.99	0.05	0.95	0.08
		7.25	1.01	0.05	0.99	0.12
	120	3.25	0.87	0.12	0.58	0.20
		5.25	0.95	0.16	0.88	0.25
		7.25	1.00	0.18	1.00	0.28
	180	3.25	0.51	0.17	0.61	0.21
		5.25	0.79	0.22	1.00	0.20
		7.25	1.10	0.23	1.12	0.18
	250	3.25	0.42	0.15	0.62	0.17
		5.25	0.68	0.13	0.67	0.27
		7.25	1.12	0.27	0.80	0.26
	300	3.25	0.32	0.05	0.33	0.00
		5.25	0.59	0.16	0.58	0.28
		7.25	0.95	0.40	0.77	0.26

Means and Standard Deviations for Parametric
Experiment: Average Time to Fire First Round for Moving Targets

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group: Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	2.25	0.29	2.31	0.72
			5.25	2.19	0.32	2.17	0.35
		12	3.25	2.09	0.39	2.19	1.03
			5.25	2.02	0.25	1.96	0.33
	120	6	3.25	2.55	0.34	2.61	0.31
			5.25	2.63	0.38	2.49	0.19
		12	3.25	2.44	0.44	2.39	0.37
			5.25	2.42	0.47	2.29	0.27
	180	6	3.25	2.80	0.33	2.85	0.35
			5.25	2.80	0.51	2.76	0.28
		12	3.25	2.57	0.40	2.56	0.37
			5.25	2.61	0.40	2.61	0.40
Field	60	6	3.25	2.03	0.27	2.11	0.25
			5.25	2.13	0.35	2.31	0.62
		12	3.25	2.07	0.44	1.98	0.16
			5.25	2.08	0.29	2.00	0.15
	120	6	3.25	2.74	0.26	2.80	0.21
			5.25	2.71	0.30	2.83	0.34
		12	3.25	2.57	0.26	2.65	0.15
			5.25	2.57	0.27	2.56	0.17
	180	6	3.25	2.65	0.26	2.69	0.32
			5.25	2.86	0.42	2.69	0.29
		12	3.25	2.81	0.41	2.61	0.33
			5.25	2.69	0.27	2.60	0.33

TABLE 5K

Means and Standard Deviations for Parametric
Experiment: Average Time to First Hit for Moving Targets

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	2.30	0.29	2.20	0.26
			5.25	2.42	0.38	2.32	0.42
		12	3.25	2.27	0.32	2.06	0.21
			5.25	2.49	0.49	2.37	0.37
	120	6	3.25	2.39	0.15	2.47	0.16
			5.25	2.99	0.42	2.96	0.31
		12	3.25	2.58	0.15	2.46	0.21
			5.25	3.17	0.62	2.94	0.40
	180	6	3.25	2.73	0.25	2.92	0.28
			5.25	3.21	0.48	3.49	0.48
		12	3.25	2.58	0.09	2.81	0.18
			5.25	3.51	0.62	3.19	0.38
Field	60	6	3.25	2.14	0.31	2.20	0.21
			5.25	2.44	0.56	2.35	0.45
		12	3.25	2.55	0.44	2.28	0.31
			5.25	2.81	0.69	2.37	0.52
	120	6	3.25	2.82	0.18	2.82	0.17
			5.25	3.19	0.54	3.33	0.58
		12	3.25	2.65	0.11	2.74	0.18
			5.25	3.18	0.49	3.07	0.40
	180	6	3.25	2.77	0.18	2.74	0.21
			5.25	3.51	0.39	3.32	0.32
		12	3.25	2.73	0.19	2.93	0.20
			5.25	3.56	0.53	3.23	0.39

TABLE 6K

Means and Standard Deviations for Parametric
Experiment: Average Number of Rounds to First Hit for Moving Targets

Treatment	Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd
Testbed	60	6	3.25	1.06	0.34	1.05	0.24
			5.25	1.48	0.33	1.25	0.33
		12	3.25	1.37	0.54	1.07	0.32
			5.25	1.63	0.46	1.64	0.61
	120	6	3.25	0.77	0.12	0.86	0.21
			5.25	1.38	0.42	1.36	0.48
		12	3.25	1.12	0.39	0.77	0.21
			5.25	1.58	0.68	1.68	0.70
	180	6	3.25	0.92	0.21	0.75	0.20
			5.25	1.48	0.47	1.30	0.64
		12	3.25	1.08	0.28	0.98	0.21
			5.25	2.23	0.89	1.20	0.67
Field	60	6	3.25	1.02	0.12	1.00	0.14
			5.25	1.34	0.28	1.16	0.27
		12	3.25	1.23	0.43	0.91	0.27
			5.25	1.33	0.40	1.20	0.34
	120	6	3.25	0.63	0.22	0.70	0.14
			5.25	1.06	0.34	0.96	0.29
		12	3.25	0.75	0.10	0.66	0.19
			5.25	1.04	0.30	0.89	0.32
	180	6	3.25	0.71	0.17	0.59	0.16
			5.25	0.90	0.28	0.93	0.25
		12	3.25	0.75	0.40	0.50	0.10
			5.25	1.00	0.25	0.88	0.31

TABLE 7K

Means and Standard Deviations for Training
Experiment (Field): Average Time to Fire First Round for Static Targets

Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	3.25	2.23	0.25	2.27	0.25	2.14	0.26
	5.25	2.30	0.23	2.36	0.35	2.23	0.33
	7.25	2.34	0.30	2.39	0.34	2.14	0.31
120	3.25	2.84	0.21	2.75	0.23	2.33	0.29
	5.25	2.92	0.31	2.67	0.29	2.30	0.21
	7.25	2.99	0.42	2.98	0.41	2.53	0.28
180	3.25	3.13	0.13	2.97	0.30	2.70	0.24
	5.25	3.40	0.40	3.22	0.41	2.77	0.30
	7.25	3.43	0.40	3.12	0.39	2.74	0.32
250	3.25	3.16	0.28	3.06	0.29	2.70	0.17
	5.25	3.40	0.35	3.15	0.34	2.81	0.37
	7.25	3.39	0.32	3.25	0.38	2.91	0.31
300	3.25	3.29	0.27	3.18	0.32	2.99	0.15
	5.25	3.70	0.38	3.59	0.39	2.94	0.40
	7.25	4.01	0.44	3.80	0.58	3.08	0.23

TABLE 8K

Means and Standard Deviations for Training
Experiment (Field): Average Time to First Hit for Static Targets

Range (m)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	3.25	2.26	0.25	2.43	0.48	2.14	0.27
	5.25	2.31	0.23	2.37	0.34	2.24	0.31
	7.25	2.38	0.27	2.48	0.47	2.34	0.34
120	3.25	2.86	0.24	2.78	0.29	2.47	0.25
	5.25	2.98	0.29	2.90	0.41	2.82	0.41
	7.25	3.28	0.56	3.39	0.55	3.34	0.54
180	3.25	3.04	0.30	3.09	0.30	2.81	0.24
	5.25	3.61	0.45	3.51	0.41	3.40	0.59
	7.25	4.07	0.72	3.60	0.49	4.28	0.78
250	3.25	3.10	0.20	3.06	0.19	3.00	0.26
	5.25	3.93	0.41	3.77	0.43	3.88	0.61
	7.25	4.20	0.75	4.09	0.85	4.78	1.20
300	3.25	3.07	0.23	3.08	0.21	3.11	0.06
	5.25	4.16	0.60	4.08	0.68	3.73	0.40
	7.25	5.03	0.71	4.59	0.80	5.22	0.77

TABLE 9K

Means and Standard Deviations for Training Experiment (Field): Average Number of Rounds to First Hit for Static Target

Range (m)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	3.25	1.00	0.09	0.93	0.11	0.96	0.11
	5.25	0.99	0.04	0.95	0.08	0.91	0.12
	7.25	1.01	0.04	0.99	0.12	1.06	0.19
120	3.25	0.88	0.12	0.58	0.20	0.72	0.12
	5.25	0.96	0.15	0.88	0.25	1.06	0.24
	7.25	1.00	0.17	1.00	0.28	1.44	0.35
180	3.25	0.51	0.16	0.61	0.21	0.65	0.19
	5.25	0.80	0.21	1.00	0.20	1.11	0.39
	7.25	1.10	0.22	1.12	0.18	1.52	0.39
250	3.25	0.42	0.14	0.62	0.17	0.43	0.12
	5.25	0.71	0.15	0.67	0.27	1.00	0.41
	7.25	1.22	0.26	0.80	0.26	1.22	0.33
300	3.25	0.32	0.04	0.33	0.00	0.50	0.00
	5.25	0.61	0.16	0.58	0.28	0.89	0.24
	7.25	0.93	0.37	0.77	0.26	1.50	0.65

TABLE 10K

Means and Standard Deviations for Training Experiment (Field): Average Time to Fire First Round for Moving Targets

Range (m)	Exposure Time (sec)		Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	6	3.25	2.03	0.27	2.11	0.25	2.06	0.45
		5.25	2.13	0.35	2.31	0.62	1.97	0.25
	12	3.25	2.07	0.44	1.98	0.16	2.10	0.39
		5.25	2.08	0.29	2.00	0.15	1.94	0.27
120	6	3.25	2.74	0.26	2.80	0.21	2.46	0.33
		5.25	2.71	0.30	2.83	0.34	2.49	0.38
	12	3.25	2.57	0.26	2.65	0.15	2.27	0.29
		5.25	2.57	0.27	2.56	0.17	2.16	0.26
180	6	3.25	2.65	0.26	2.69	0.32	2.69	0.34
		5.25	2.86	0.42	2.69	0.29	2.59	0.29
	12	3.25	2.81	0.41	2.61	0.33	2.29	0.31
		5.25	2.69	0.27	2.60	0.33	2.17	0.28

TABLE 11K

Means and Standard Deviations for Training Experiment (Field): Average Time to First Hit for Moving Targets

Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Alpha sd	Bravo mn	Bravo sd	ROTC mn	ROTC sd
60	6	3.25	2.14	0.31	2.20	0.21	2.13	0.49
		5.25	2.44	0.56	2.35	0.45	2.27	0.47
	12	3.25	2.55	0.44	2.28	0.31	2.38	0.22
		5.25	2.81	0.69	2.37	0.52	2.48	0.25
120	6	3.25	2.82	0.18	2.82	0.17	2.66	0.17
		5.25	3.19	0.54	3.33	0.58	2.80	0.60
	12	3.25	2.65	0.11	2.74	0.18	2.56	0.25
		5.25	3.18	0.49	3.07	0.40	2.63	0.21
180	6	3.25	2.77	0.18	2.74	0.21	2.80	0.26
		5.25	3.51	0.39	3.32	0.32	3.30	0.66
	12	3.25	2.73	0.19	2.93	0.20	2.67	0.22
		5.25	3.56	0.53	3.23	0.39	3.37	0.48

TABLE 12K

Means and Standard Deviations for Training Experiment (Field): Average Number of Rounds to First Hit for Moving Targets

Range (m)	Speed (feet/sec)	Exposure Time (sec)	Group Alpha mn	Group Alpha sd	Group Bravo mn	Group Bravo sd	ROTC mn	ROTC sd
60	6	3.25	1.03	0.13	1.00	0.14	0.92	0.22
		5.25	1.13	0.27	1.16	0.27	1.14	0.18
	12	3.25	1.22	0.42	0.91	0.27	0.94	0.37
		5.25	1.37	0.41	1.20	0.34	1.33	0.35
120	6	3.25	0.65	0.21	0.70	0.14	0.72	0.26
		5.25	1.12	0.36	0.96	0.29	0.94	0.27
	12	3.25	0.75	0.09	0.66	0.19	0.75	0.28
		5.25	1.05	0.29	0.89	0.32	1.03	0.34
180	6	3.25	0.73	0.18	0.59	0.16	0.61	0.13
		5.25	0.88	0.28	0.93	0.25	1.25	0.35
	12	3.25	0.75	0.37	0.50	0.10	0.86	0.13
		5.25	0.93	0.31	0.88	0.31	1.19	0.17

APPENDIX L

FIGURES DISPLAYING RATE OF FIRING MARKSMANSHIP PERFORMANCE MEASURES

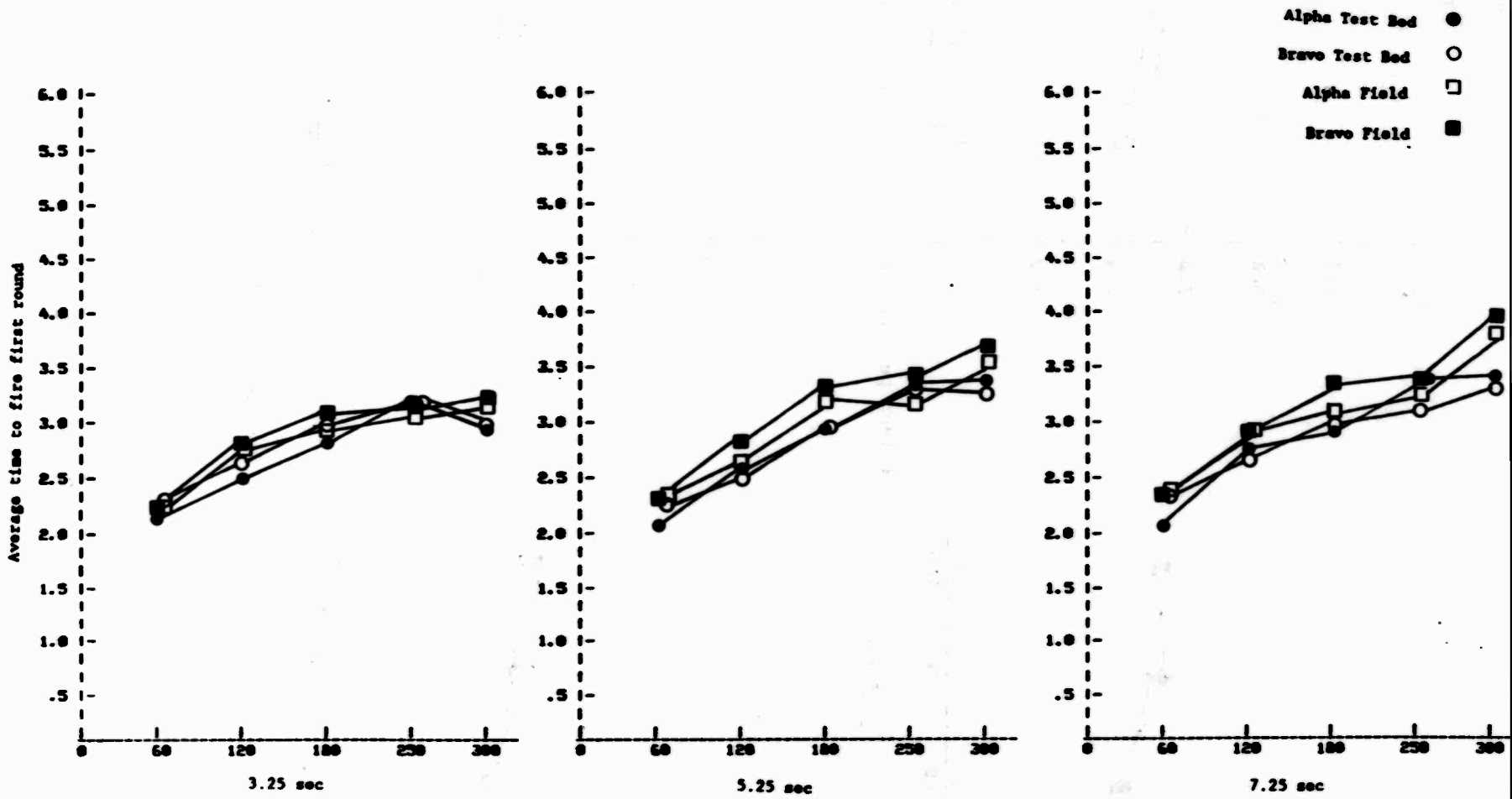


Figure 1L. Average time to fire first round, static targets, Parametric Experiment.

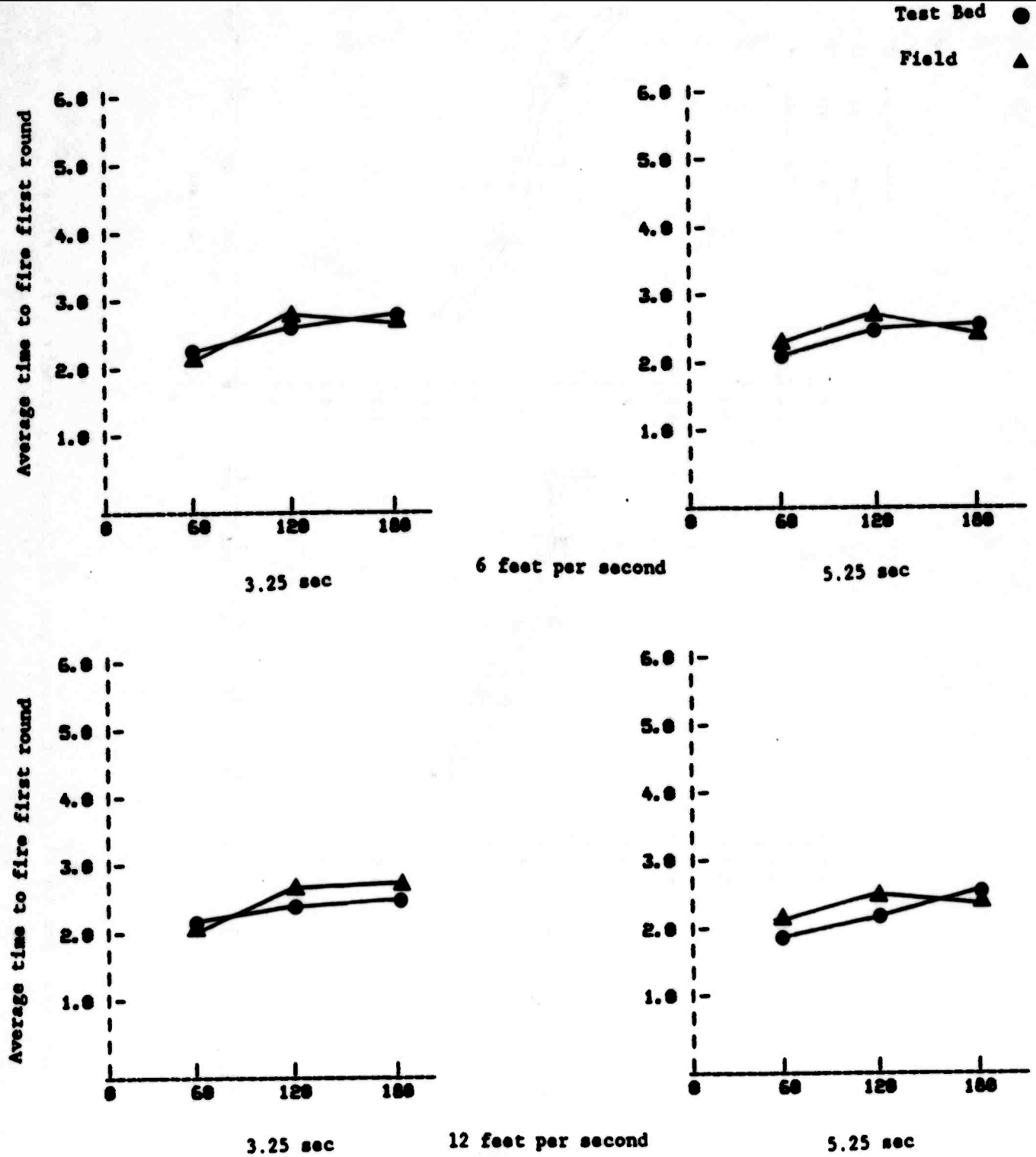


Figure 2L. Average time to fire first round, moving targets, Parametric Experiment.

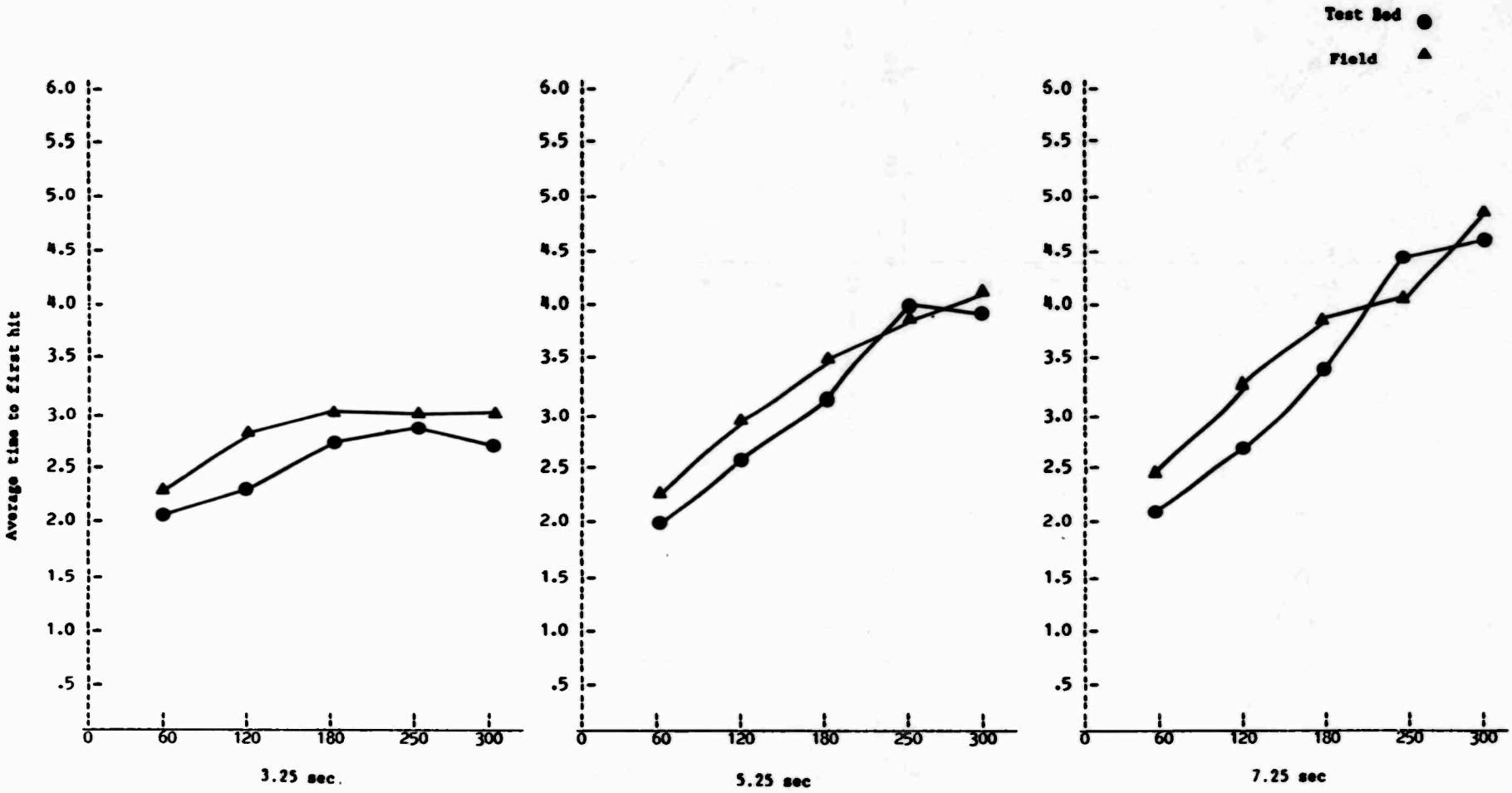


Figure 3L. Average time to first hit, static targets, Parametric Experiment.

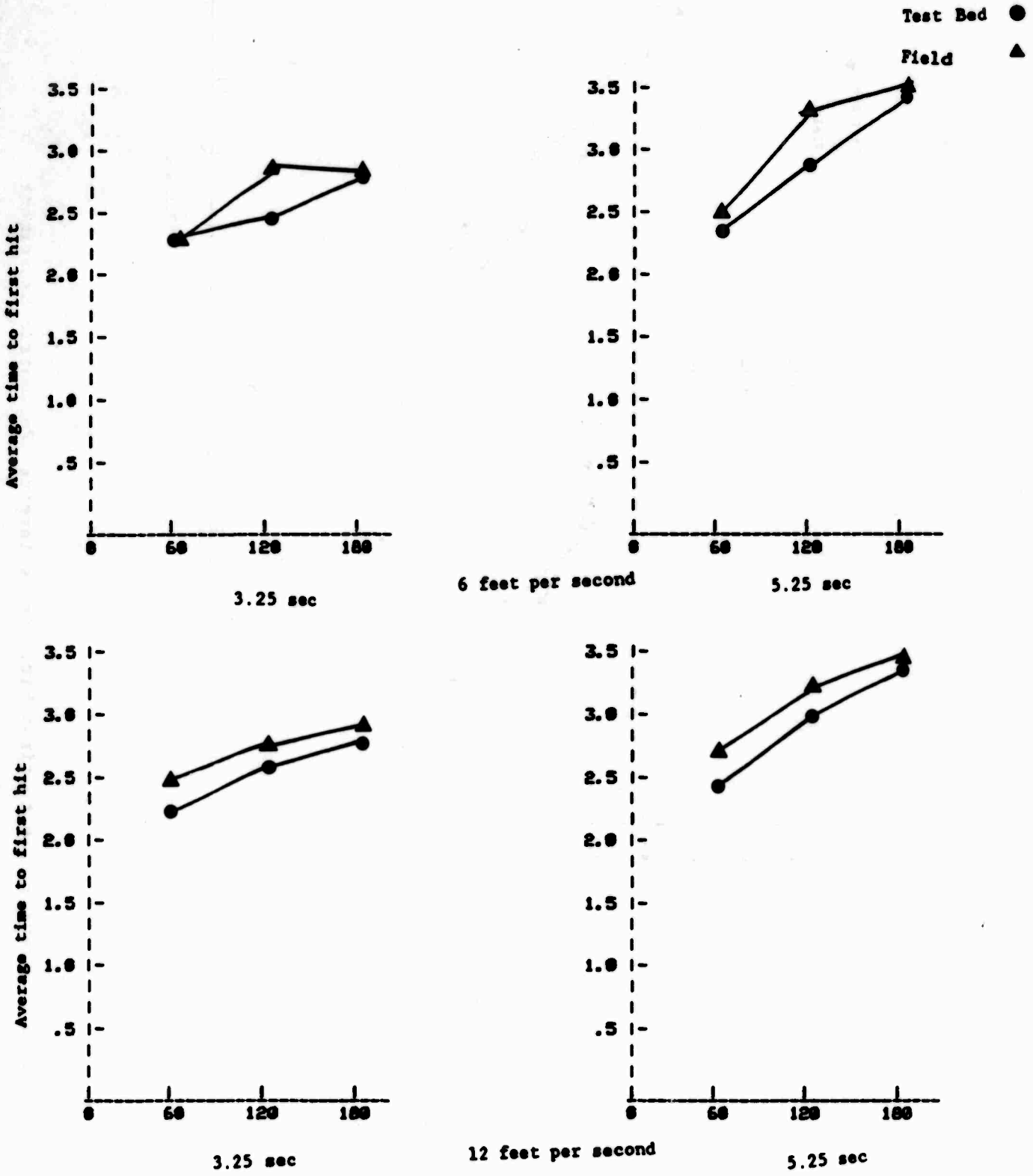


Figure 4L. Average time to first hit, moving targets, Parametric Experiment.

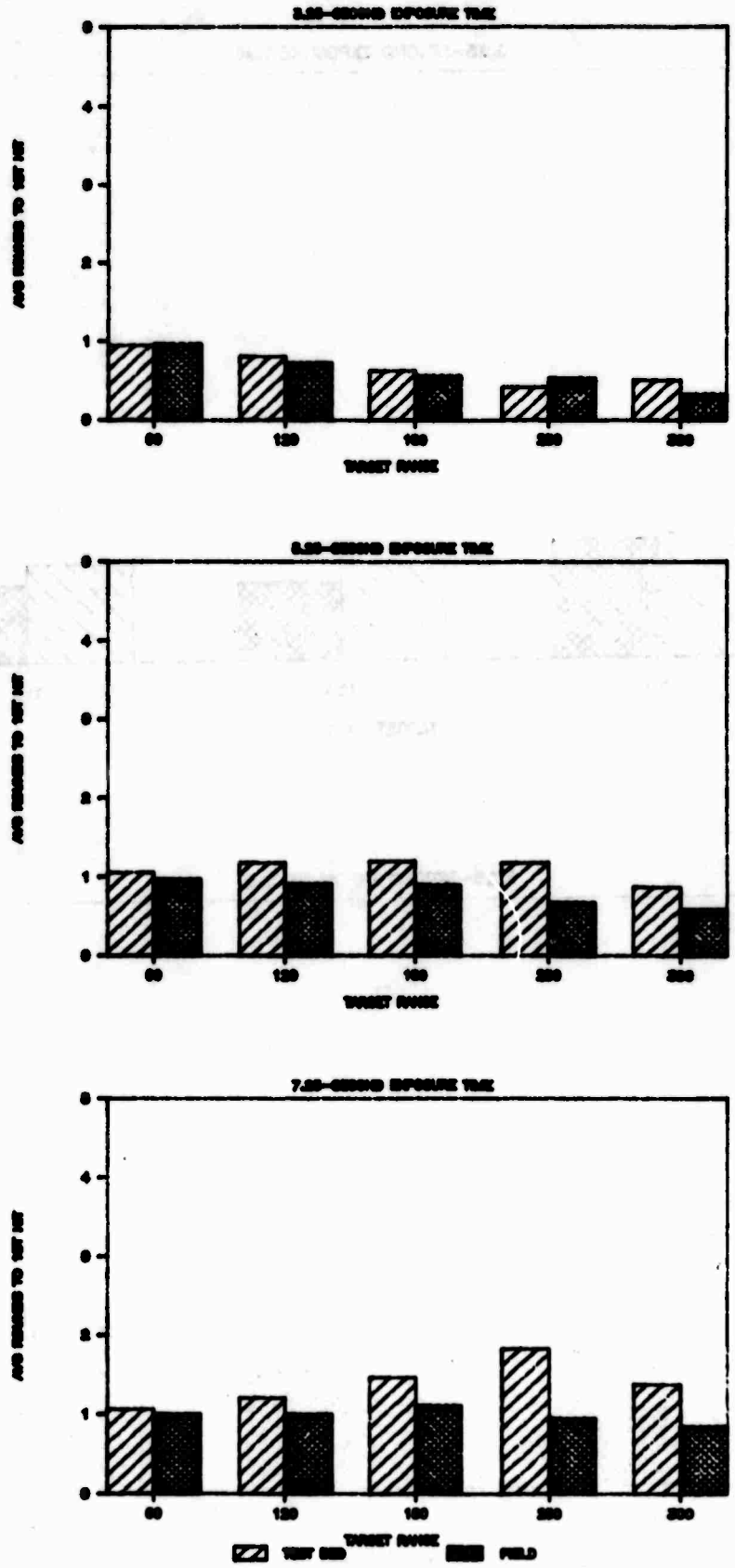


Figure 5L. Average rounds to first hit for static targets, as a function of treatment, target range, and exposure time.

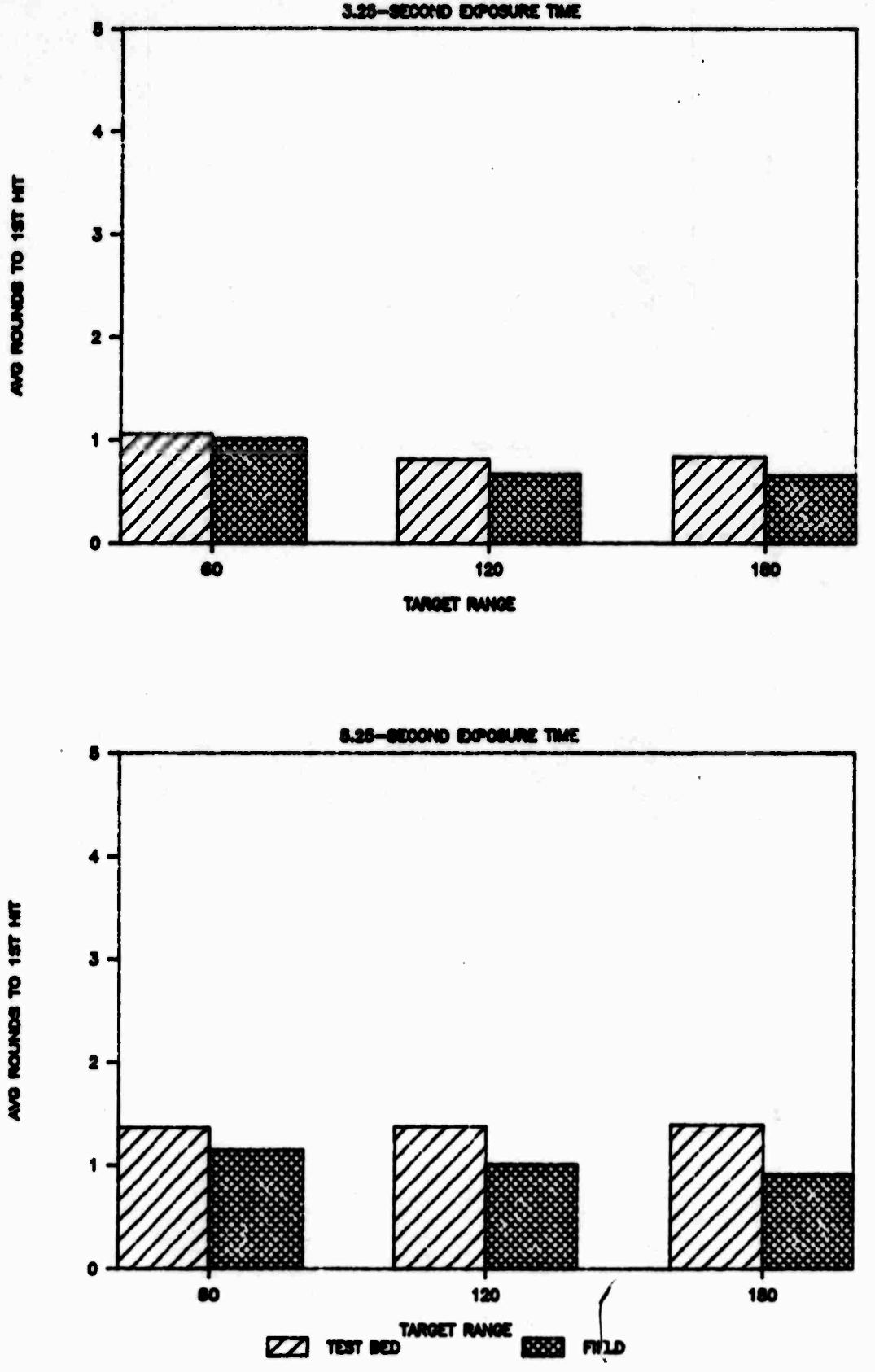


Figure 6L. Average rounds to first hit for slow moving targets as a function of treatment, target range, and exposure time.

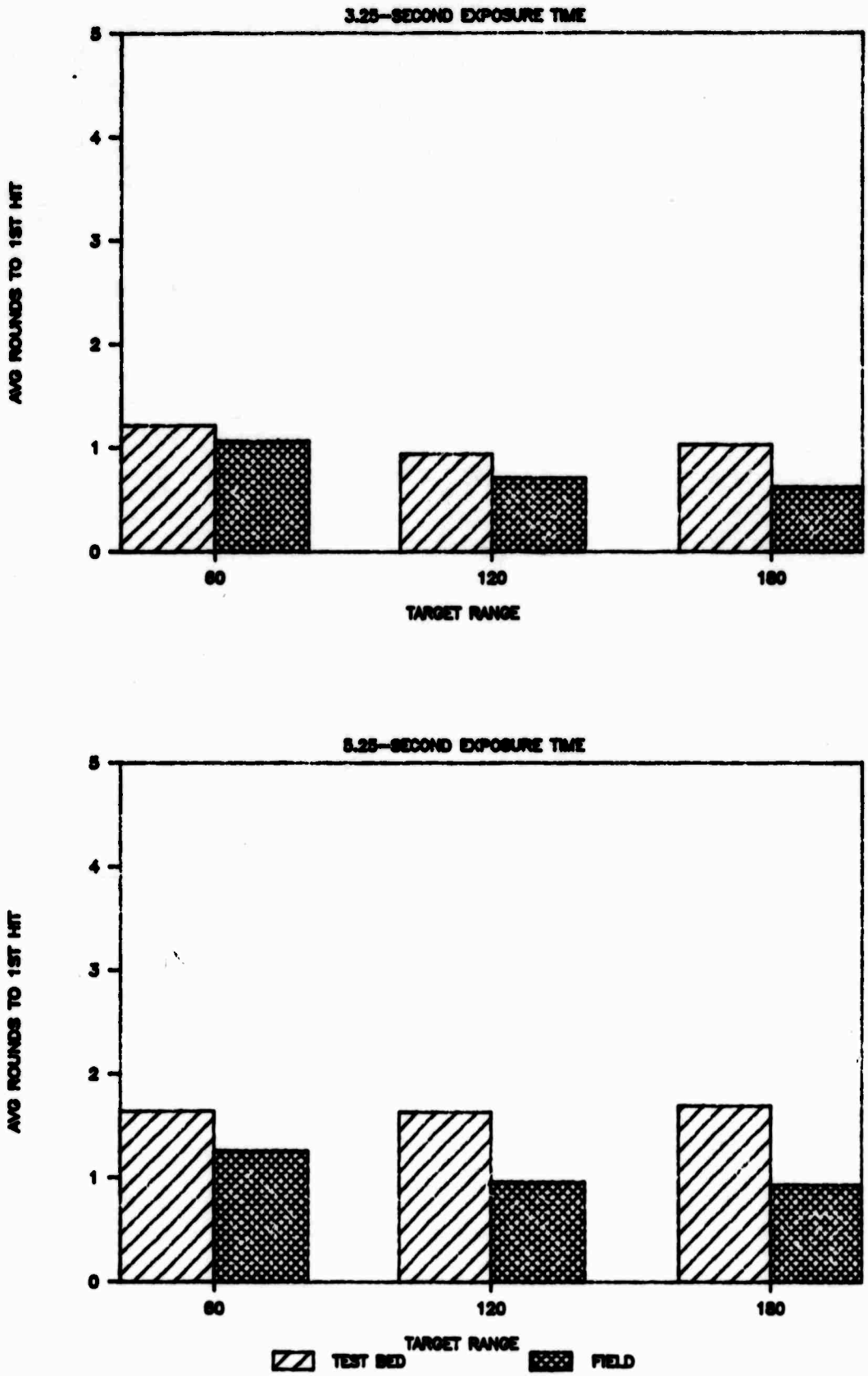


Figure 7L. Average rounds to first hit for fast moving targets as a function of treatment, target range, and exposure time.

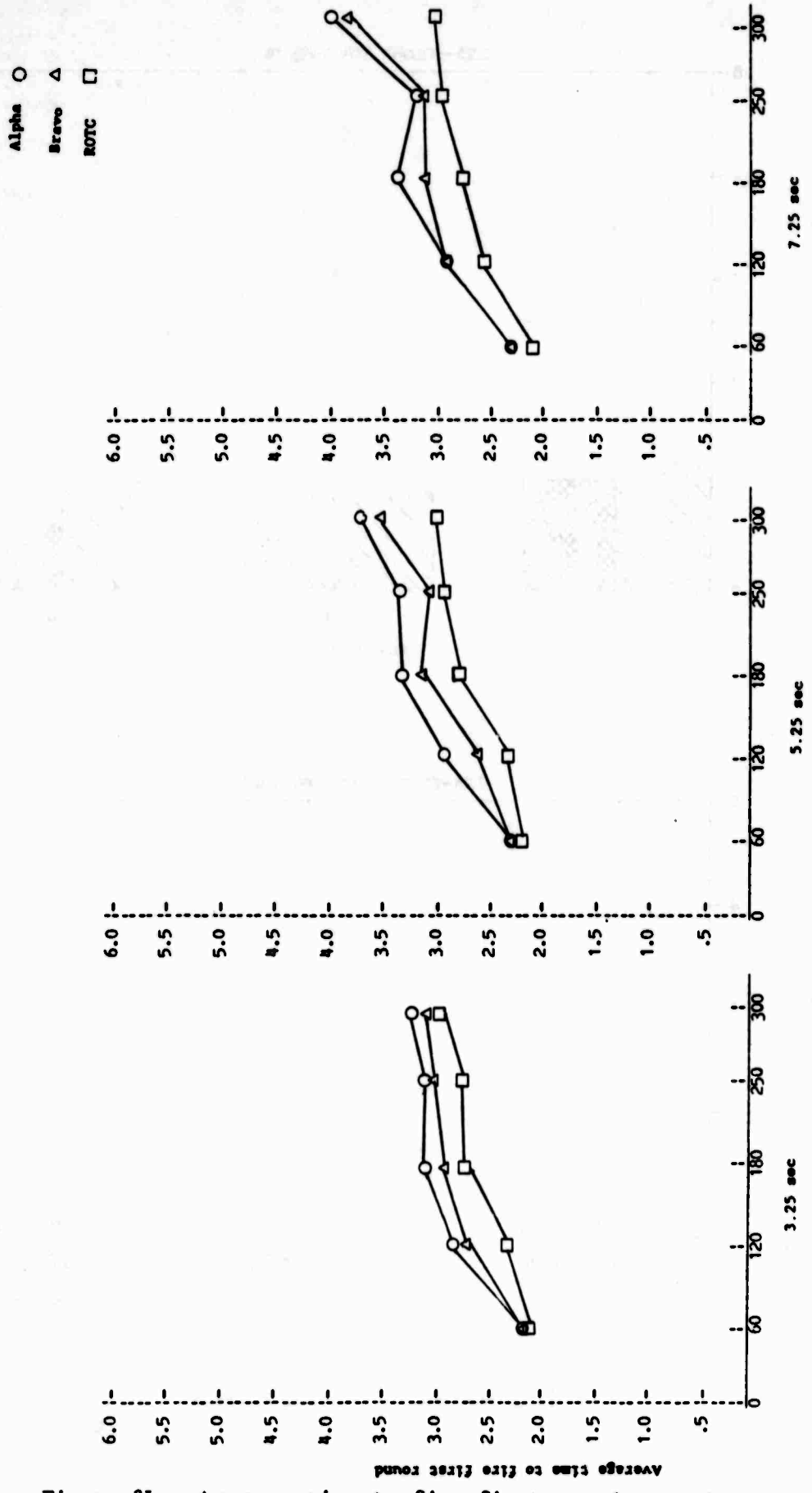


Figure 8L. Average time to fire first round, static targets, Training Experiment.

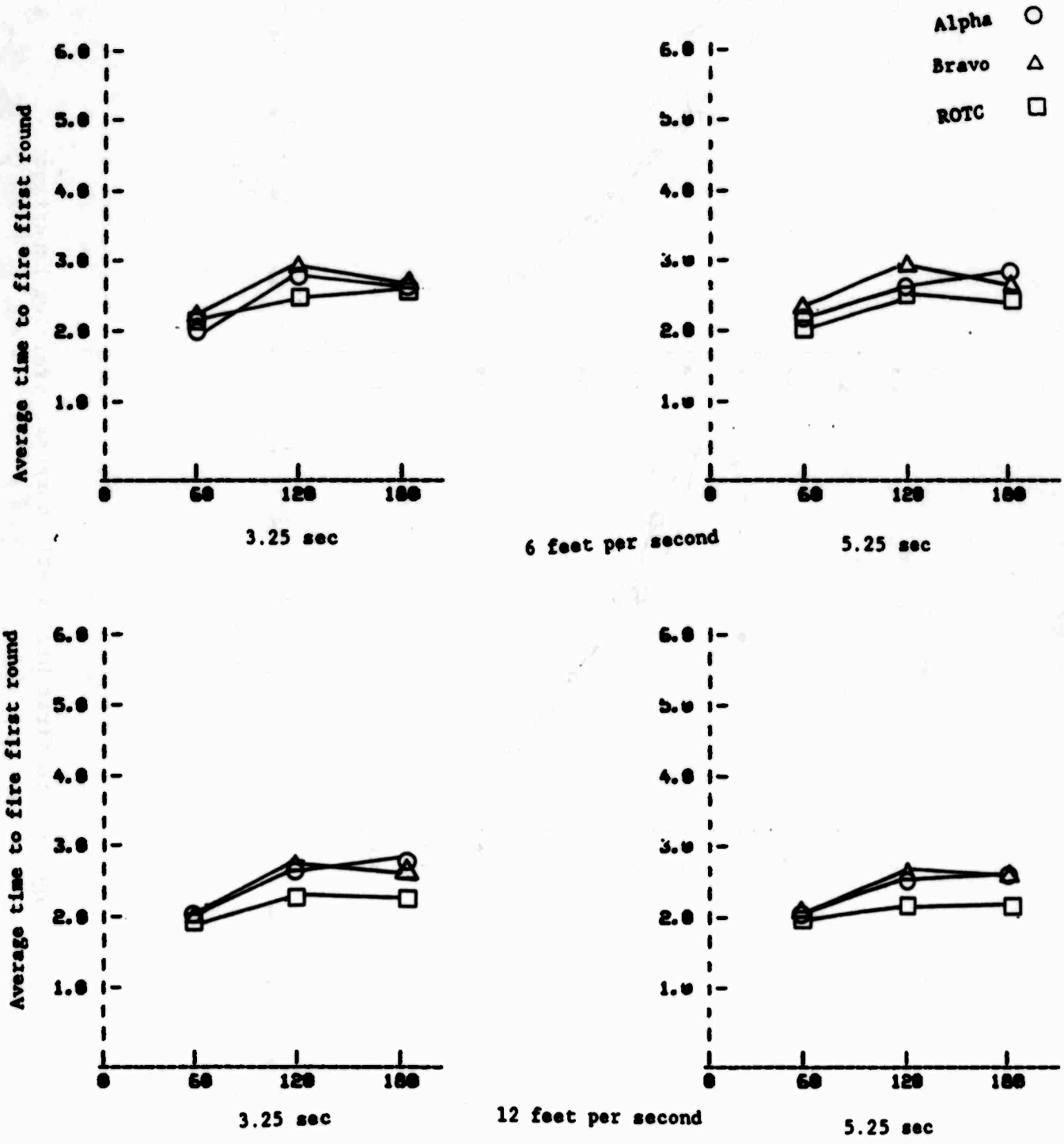


Figure 9L. Average time to fire first round, moving targets, Training Experiment.

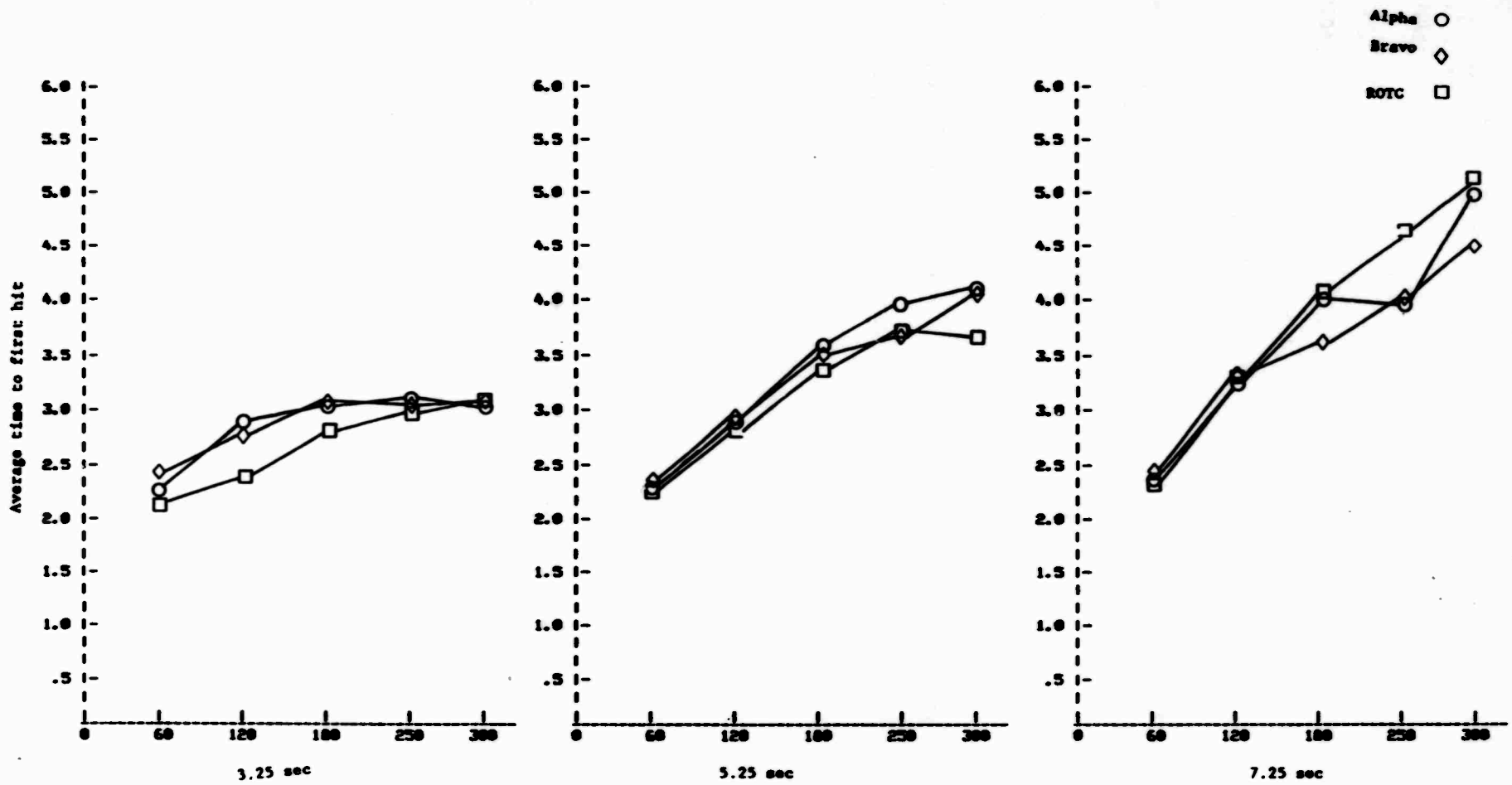


Figure 10L. Average time to first hit, static targets, Training Experiment.

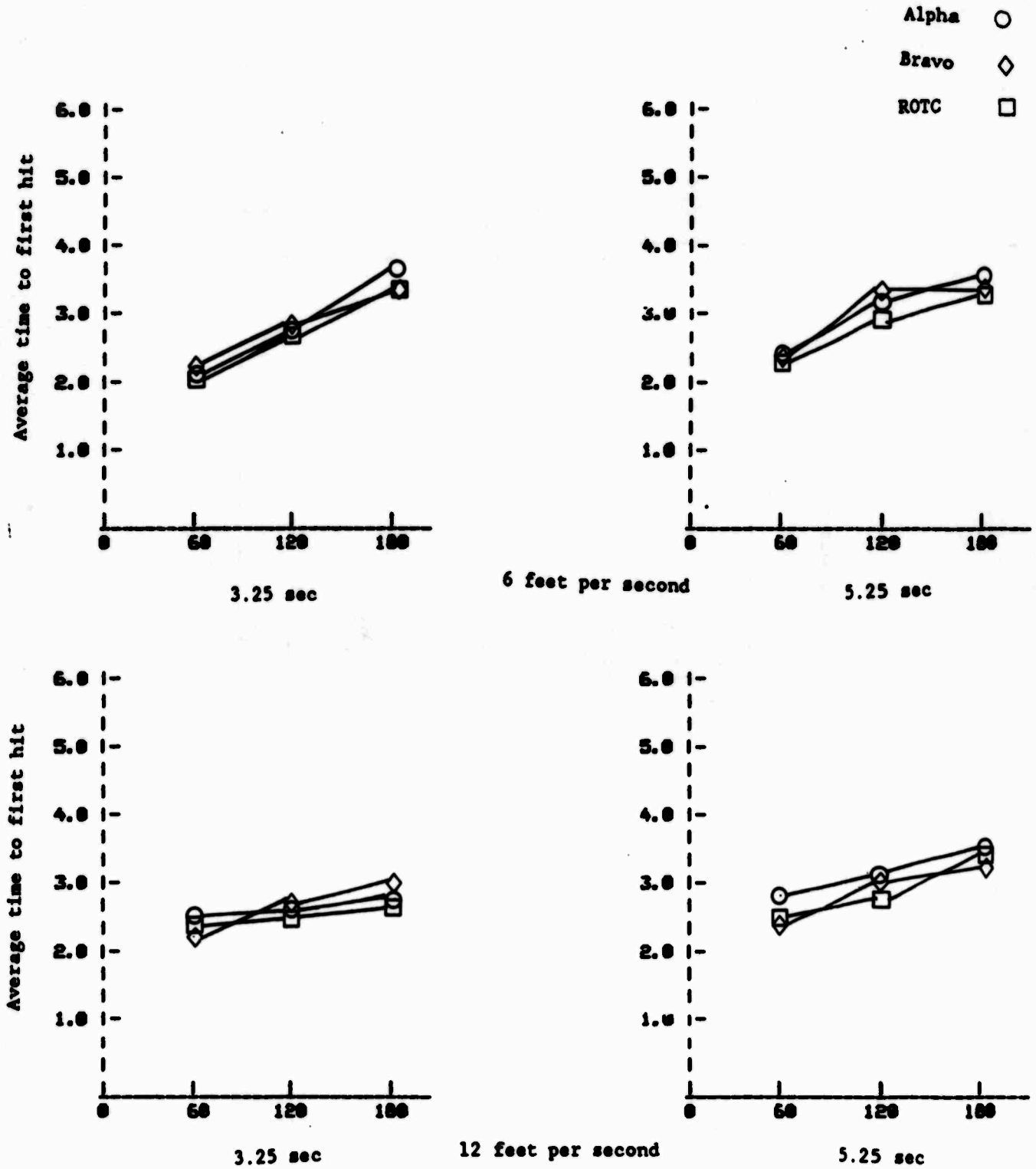


Figure 11L. Average time to first hit, moving targets, Training Experiment.

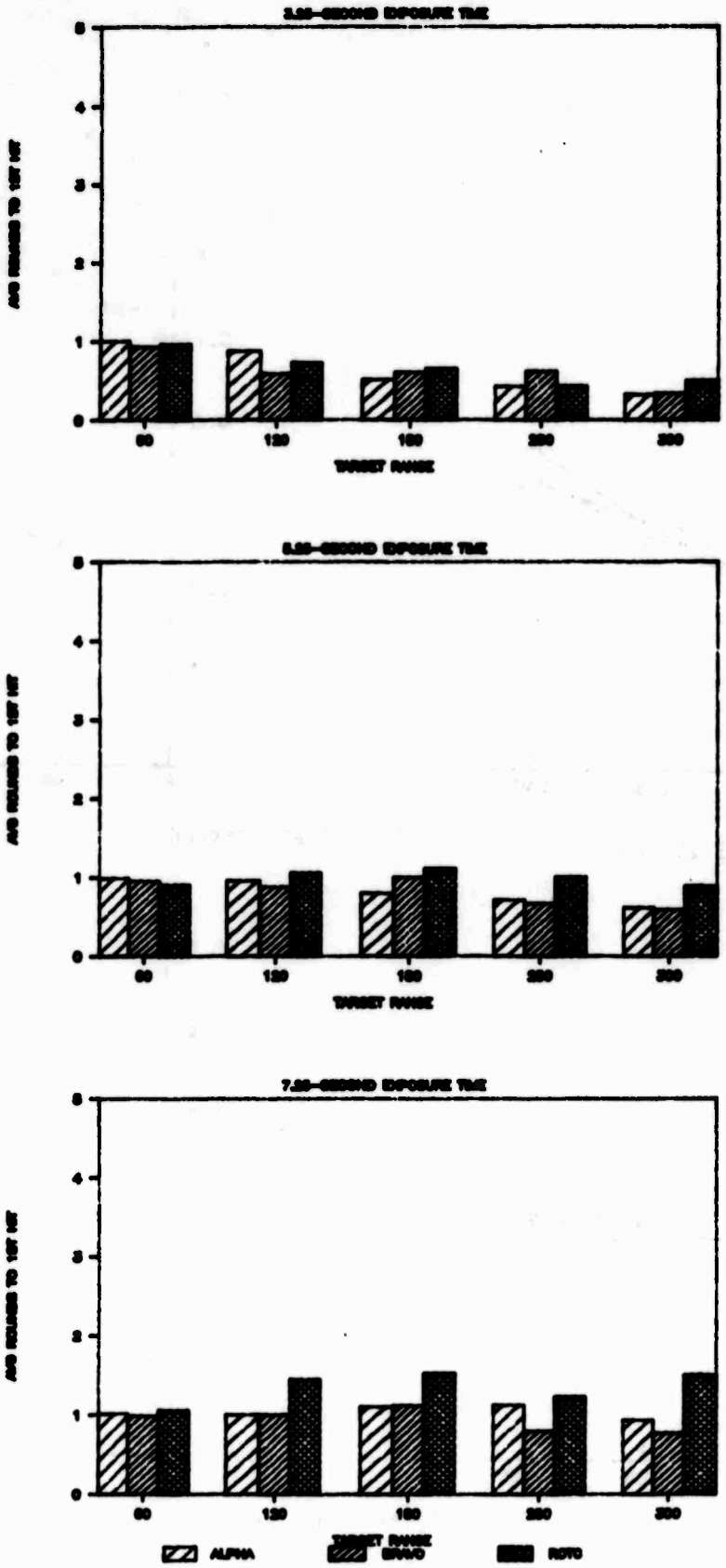


Figure 12L. Average rounds to first hit for static targets as a function of group, target range, and exposure time.

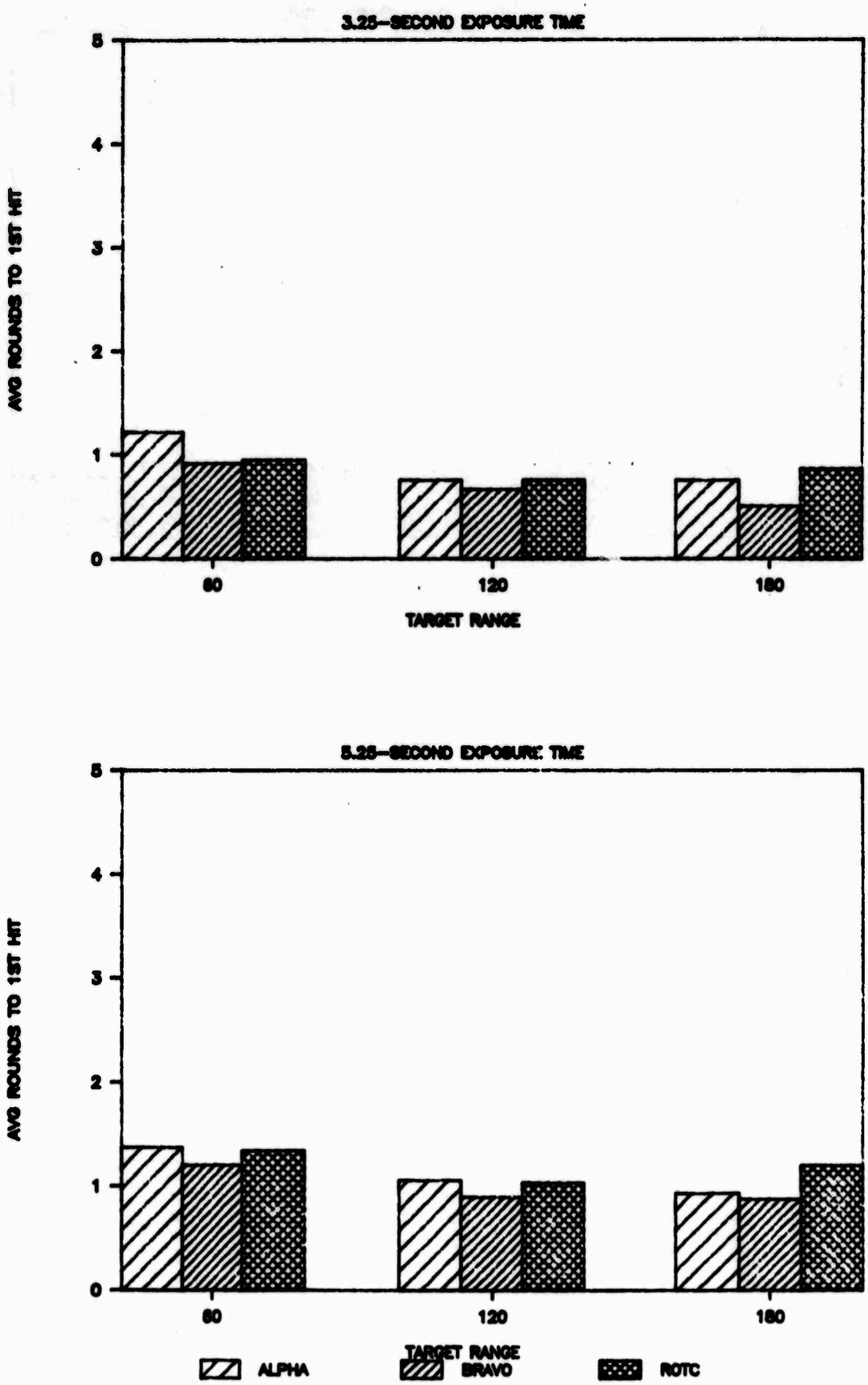
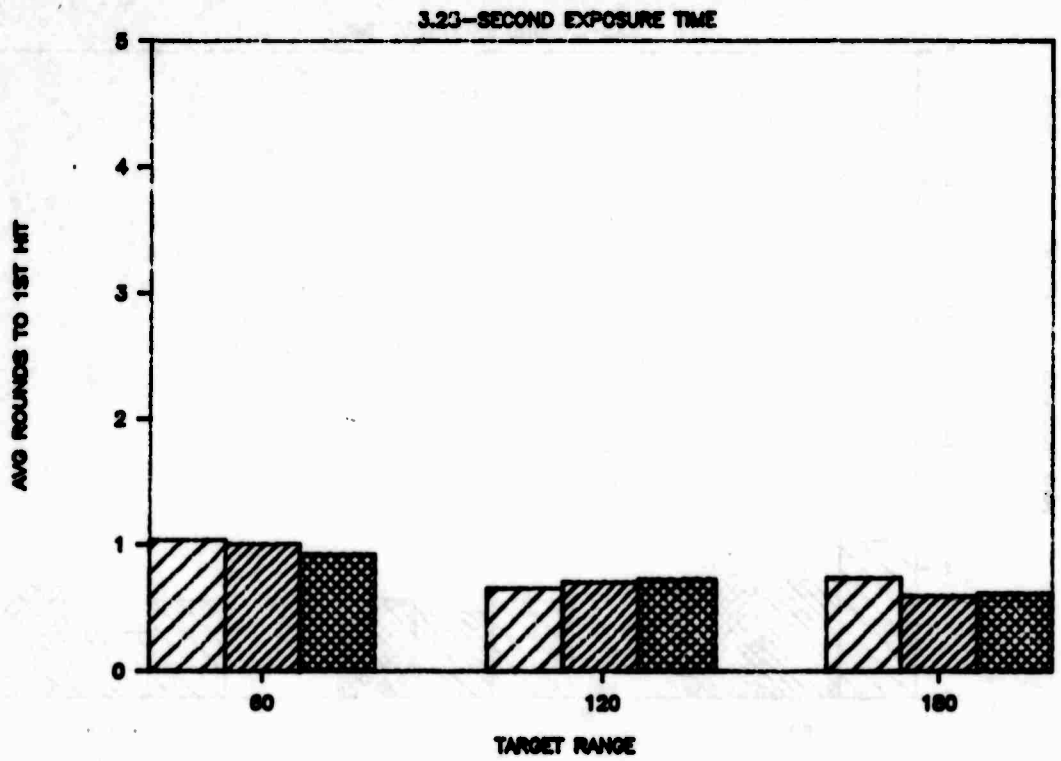


Figure 13L. Average rounds to first hit for fast moving targets as a function of group, target range, and exposure time.



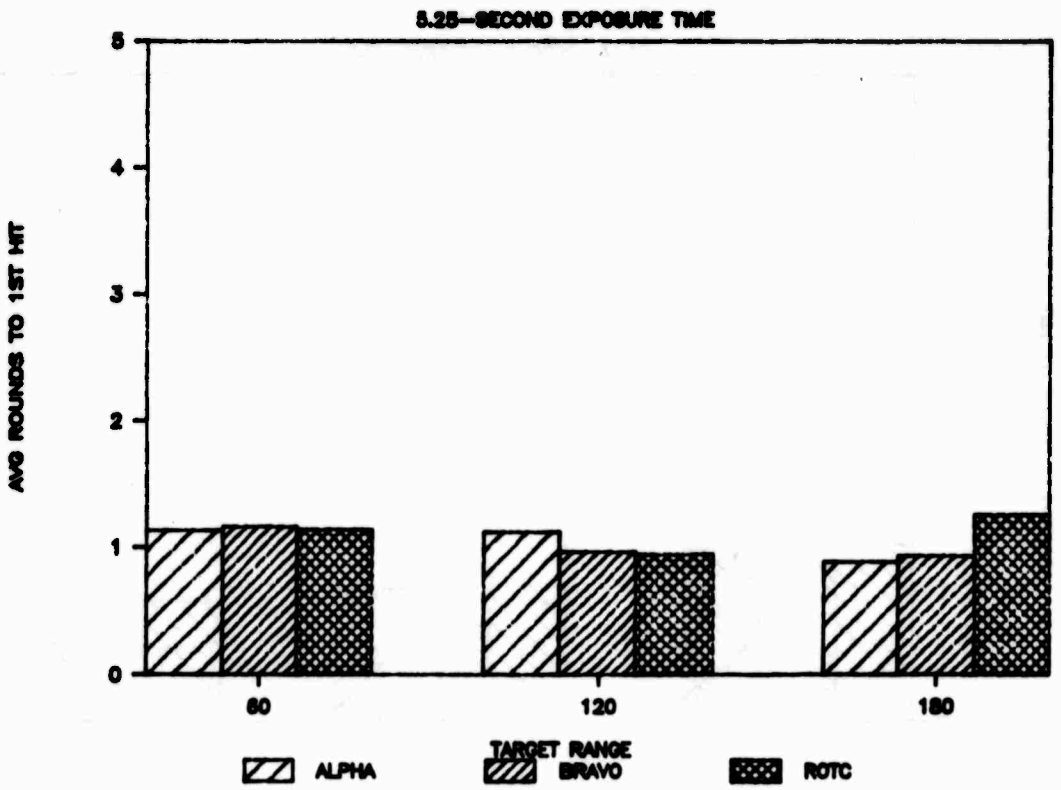


Figure 14L. Average rounds to first hit for slow moving targets as a function of group, target range and exposure time.